NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

HEAT TRANSFER MODELLING OF THRUST VECTOR CONTROL SYSTEMS

by

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March 1986

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SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION: Naval Postgraduate School 6b. OFFICE SYMBOL (If applicable): Code 69	7a. NAME OF MONITORING ORGANIZATION: Naval Postgraduate School
6c. ADDRESS (City, State, and ZIP Code): Monterey, California 93943-5000	7b. ADDRESS (City, State, and ZIP Code): Monterey, California 93943-5000
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO / TASK NO / WORK UNIT ACCESSION NO.

11 TITLE (Include Security Classification)

HEAT TRANSFER MODELLING OF THRUST VECTOR CONTROL SYSTEMS

12 PERSONAL AUTHOR(S)
Yukselen, Alp

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Master's thesis	FROM TO	1986 March	199

16 SUPPLEMENTARY NOTATION

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Heat Transfer Modelling; TVC

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

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20 DISTRIBUTION/AVAILABILITY OF ABSTRACT	21 ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	Unclassified

22a NAME OF RESPONSIBLE INDIVIDUAL	22b TELEPHONE (Include Area Code)	22c OFFICE SYMBOL
Matthew Kelleher	(408) 646-2530	Code 69Kk

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

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Heat Transfer Modelling of Thrust Vector Control Systems

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MECHANICAL ENGINEERING

from the

NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

This thesis presents a model of heat transfer phenomenon in thrust vector control systems, using the PHOENICS computer code.

To simplify the problem of heat transfer to solid objects in rocket exhaust, simple wedge bodies have been examined in supersonic gas flow for both turbulent and laminar flow cases.

The study gives an estimate of skin friction coefficient, surface heat flux, heat transfer coefficient, Stanton number distributions, and computer run times.

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I. INTRODUCTION

The use of external aerodynamics in the control of rocket trajectory, necessiates an active control system which generates a force on external surfaces to accomplish specified trajectory changes, and to balance external disturbances such as wind and pressure forces. This type of trajectory control is most effective at high velocities and low altitudes. At high altitudes or low velocities the effectiveness of external surfaces for missile maneuvering or trajectory control decreases markedly. Under these operating conditions other control mechanisms must be used such as jetvanes and jet tabs. Adding a jet vane or a jet tab into nozzle exit, a capability to change and control the direction of thrust can be obtained. The basic principle of thrust vector control by using vane has been shown in Figure 1.1

Jet vanes are a preferable means of thrust vector control, provided the following requirements can be met: simplicity of design; minimum weight; minimum material erosion for maintenance of lift effectiveness; minimum thrust loss or drag; adequate load carrying ability for the duration of firing; readily produceble; low cost.

The heat transfer modelling of thrust vector control vane requires a boundary layer analysis. Following Prandtl, the classical method of solving viscous boundary layer type problems first calculates a streamwise pressure distribution from purely inviscid considerations and then calculates the boundary layer development under the influence of this inviscid pressure distribution. No attempt is made to correct the inviscid pressure calculation for viscous effects originating in boundary layer region. Obviously, such a two step procedure can be valid only if the pressure

distribution calculated ignoring viscous effects is a sufficiently good approximation to the pressure distribution which actually occurs. In many cases of practical interest, the inviscid pressure distribution is an excellent approximation to physical reality and in these cases the classical two step procedure is valid.

The rapid development of both numerical techniques and computer capability now have made it practical to apply Navier-Stokes calculation procedures to the boundary layer problem. Since the Navier-Stokes equations represent the exact equations of motion, they contain no approximations other than those made in connection with turbulence modeling. For example the assumption of constant pressure at any stream wise station which is inherent in most boundary layer procedures and which may be in serious error in supersonic flow is relieved in the Navier-Stokes approach. Further more, the approximation of convective terms in the separated flow regions which is necessary for numerical stability in boundary layer calculations is not required in the Navier-Stokes calculations.

The advantage of the Navier-Stokes numerical solutions must be balanced against certain disadvantages such as code complexity, code run time and code storage requirements. A consideration of both the advantages and disadvantages of Navier-Stokes numerical solutions indicate that potentially increased accuracy of this approach may well balance out the increased requirements in computer storage and run time.

Recently numerical solutions of the Navier-Stokes equations by a variety of authors including Baldwin and Maccormak [Ref. 1], and Shank, Hankey and Law [Ref. 2], have compared predictions for a series of incident shock wave boundary layer interactions with experimental data. Good agreement was obtained between the calculations and experiment.

The present work addresses the heat transfer modelling of thrust vector control systems. In this effort the Navier-Stokes approach is applied by using a computer code which is capable of simulating a large number of fluid flow, heat transfer and chemical reaction processes which arise in industry and elsewhere. The name of this code is PHOENICS. PHOENICS is an acronym standing for: 'Parabolic, Hyperbolic Or Elliptic Numerical Integration Code Series'. The name comes from the fact that the differential equations of fluid flow etc. arise in forms classified by mathematicians as parabolic, hyperbolic or elliptic; and PHOENICS solves these equations, whatever their form.

Built into PHOENICS are the major conservation laws of physics (mass, momentum, and energy) applied to a large number of contiguous subdomains some times called 'cells', into which the domain of study is artificially divided. The number of cells can be few or many according to the requirements of the problem. Because of the numerical stability the restriction on cell refinement, can become particularly burdensome in the calculation of a turbulent boundary layer where a very fine mesh near the wall may be required.

When supplied with appropriate information concerning: the physical properties of the materials ; the geometrical and other constraints; the inlet and/or initial conditions; PHOENICS computes the corresponding solutions to the relevant differential equations, expressing them as tables of numbers describing the field of velocity, temperature, concentration etc.

Detailed information about PHOENICS is given in [Ref. 3].

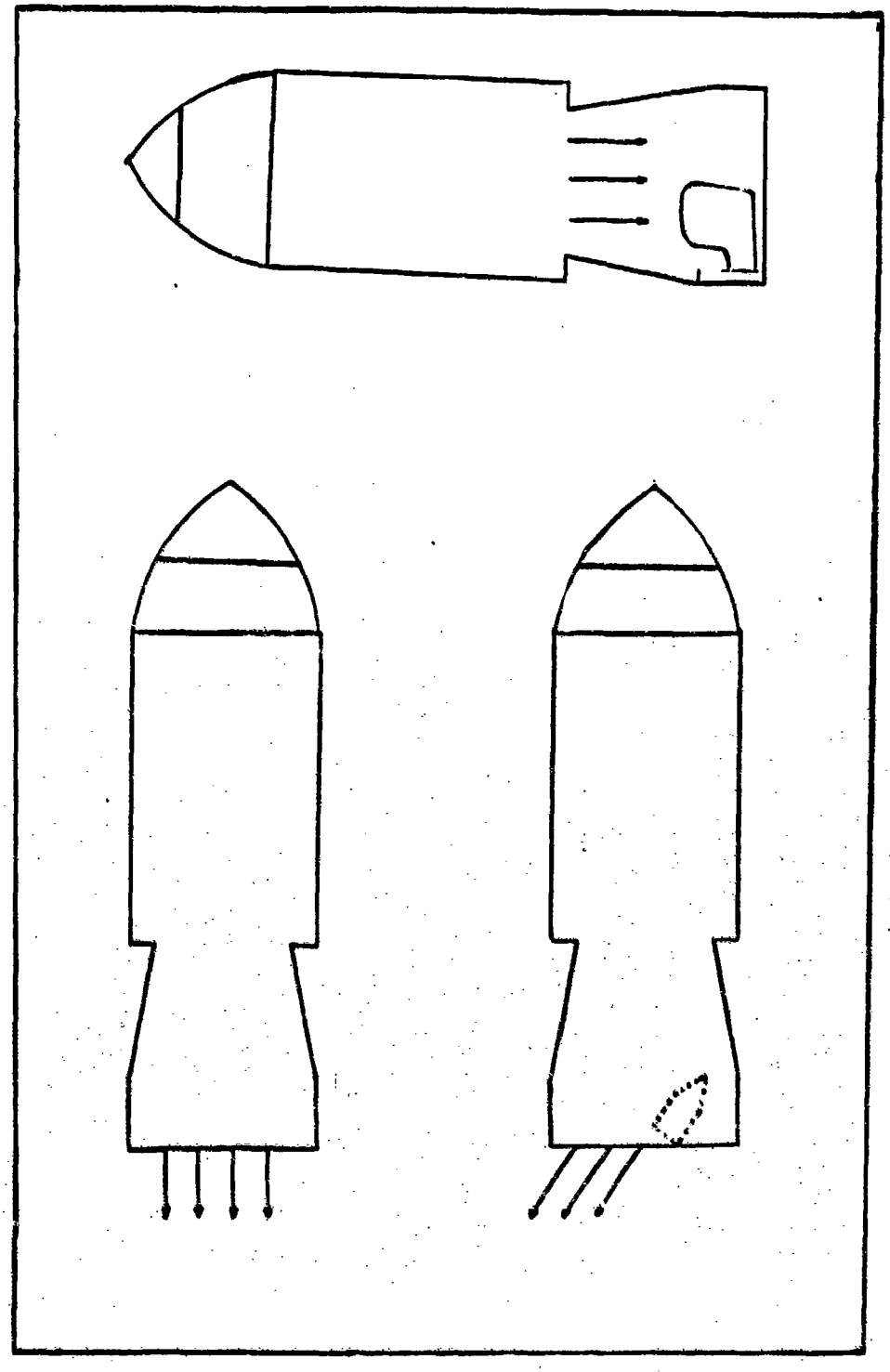

Figure 1.1 TVC Using Vane.

II. THEORETICAL BACKROUND

A. A BRIEF DISCUSSION ON NAVIER-STOKES APPROACH

Rapid advances in both numerical analysis and computer techonology make Navier-Stokes procedures a possible alternative to boundary layer procedures which are necessary for heat transfer modelling of thrust vector control systems. Solutions based upon the Navier-Stokes equations need not make an arbitrary division between viscous and inviscid portions of flow field. In addition, Navier-Stokes procedures solve a full transverse momentum equation and need not make any approximation to the convection terms in separated flow regions. These considerations indicate that even if a Navier-Stokes procedure requires much computer resources (storage and run time) its potentially increased accuracy may make it an attractive alternative.

1. Governing Equations

In this effort to obtain governing equations, one phase flow and negligible source term contributions have been assumed. Under these assumptions the basic equations in [Ref. 3], reduce to the following:

CONSERVATION OF MASS

$$-\frac{\partial \rho}{\partial t} = - \nabla.(\rho \vec{v}) \qquad \text{(eqn 2.1)}$$

CONSERVATION OF MOMENTUM

$$-\frac{\partial}{\partial t}(\rho \phi) + \nabla.(\rho \vec{v} \phi - \mu_{eff} \nabla\phi) = \nabla P \qquad \text{(eqn 2.2)}$$

Where ϕ's are the v, w velocity components for y and z directions, and the velocity vector is; $\vec{v} = v\,\vec{j} + w\,\vec{k}$

CONSERVATION OF ENERGY

$$-\frac{\partial}{\partial t}(\rho h) + \nabla\cdot(\rho \vec{v} h - \frac{\mu}{Pr}\nabla h) = \frac{Dp}{Dt} \qquad \text{(eqn 2.3)}$$

$$h = C_p T_o$$

where h is the stagnation enthalpy of the gas and T_o is the stagnation temperature.

In the case of laminar flow the governing equations (2.1), (2.2), (2.3) are sufficient to determine a solution when proper boundary conditions are applied.

However in turbulent flow it is necessary to hypothesize a turbulent model relating the turbulent viscosity to the other problem variables.

2. The Turbulent Model

The Model used in this effort is k,ϵ model, which is used in Phoenics [Ref. 3], where k is turbulent kinetic energy and ϵ is the rate of dissipation per unit volume.

To obtain turbulent flow solution following turbulent model equations have been used by PHOENICS.

$$\frac{Dk}{Dt} = -\frac{\partial}{\partial x_j}\left(\frac{\nu_{eff}}{\sigma_k}\frac{\partial k}{\partial x_j}\right) + G_k - \epsilon \qquad \text{(eqn 2.4)}$$

$$-\frac{D\varepsilon}{Dt} = -\frac{\partial}{\partial x_j}\left(\frac{\nu_{eff}}{\sigma_\varepsilon}\frac{\partial \varepsilon}{\partial x_j}\right) + -\frac{\varepsilon}{k}\left(C_1 G_k - C_2 \varepsilon\right) \quad \text{(eqn 2.5)}$$

Where

$$G_k = \nu_T\left(\frac{\partial \bar{u}_i}{\partial x_j} + \frac{\partial u_i}{\partial x_i}\right)\frac{\partial \bar{u}_i}{\partial x_j} \quad \text{(eqn 2.6)}$$

$$\nu_{eff} = \nu_{lam} + \nu_T = \nu_{lam} + \frac{C_D k^2}{\varepsilon} \quad \text{(eqn 2.7)}$$

where the constants C_1, C_2, $\mathbb{C}_k$, $\mathbb{C}_\varepsilon$, C_D are automatically provided in PHOENICS.

3. Grid Generation and Use of the Non Uniform Grid

The accuracy of solutions which are computed with a given number of grid points often can be improved by using a nonuniform grid spacing to ensure a finer mesh where the solution varies rapidly. In the interaction flow field large gradients are present near the wall and consequently fine grid resolution is desired in this region.

Within each cell is a "typical point (called a grid node)" for which the fluid property values are regarded as representative of the whole cell.

Discretization, interpolation, and integration of these equations leads to finite domain equations "FDE's" having the form:

$$a_p \phi_p = a_N \phi_N + a_S \phi_S + a_E \phi_E + a_W \phi_W + a_H \phi_H + a_L \phi_L + a_T \phi_T + b$$

Where subscripts have the meaning; P, typical point (i.e., node) within cell, N, north neighbour node, S, south neighbour node, E, east neighbour node, W, west neighbour node, H, high neighbour node, L, low neighbour node, T, grid node at earlier time, a_P, a_N, etc are coefficients, and b is a representation of the source of ϕ for the cell.

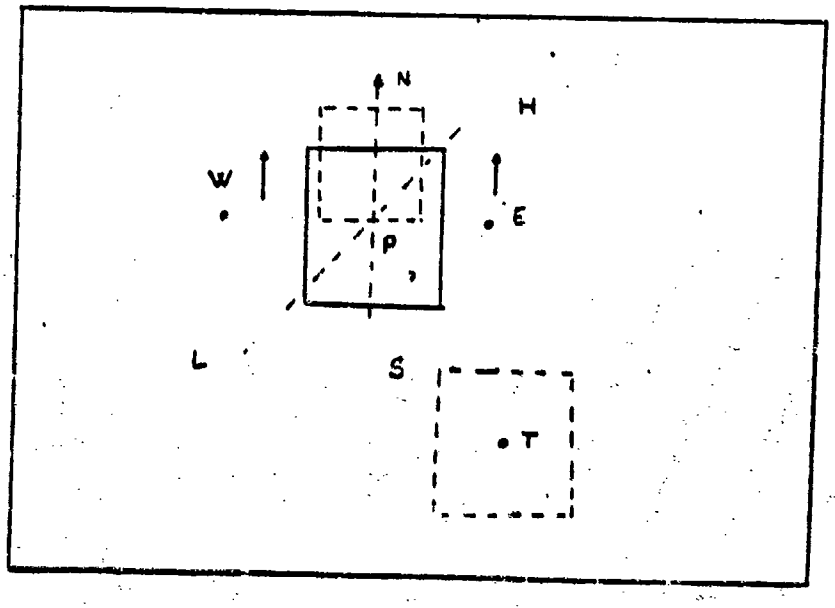

Figure 2.1 Use of Grids.

III. USE OF THE MODEL

In this effort the typical TVC vane as shown in Figure 3.1 is approximated by the wedge geometry shown in Figure 3.2 This geometry consists of two sections. First section has an inclination of 4 degrees with respect to symetry axis and the second section is the flat part which has 3.2 milimeter length. The total length and the thickness of the vane are 95.2 and 6.4 milimeters.

A. PROPERTIES

For both laminar and turbulent flow cases the properties were given as follows:

Stagnation pressure (Po)=$55*10^5$Pa

Stagnation temperature (To)=555.55 °K

Gas constant=287 Joule/kg.°K

Specific heat ratio=1.35

Constant pressure specific heat (Cp)=kR/(k-1) Joule/kg.°K

Density $\rho = \rho_o \left(\frac{p}{p_o}\right)^{1/k}$ $\frac{kg}{m^3}$

where subscript o represents stagnation values. (Except across the oblique shock, this isentropic assumption is true in the whole flow field.)

Viscosity $\mu = 0.1716 * 10^{-5} * \left(\frac{T}{273}\right)^{0.666}$ $N\,s\,/\,m^2$

where T is static temperature, in °K.

In addition to properties above, for the turbulent flow case an effective viscosity is used.

$$\mu_{eff} = \frac{C_\mu \rho k^2}{\varepsilon} + \mu_{lam} \qquad \text{(eqn 3.1)}$$

B. INITIAL FIELDS

Necessary values to initialize the fields for both laminar and turbulent cases, assuming isentropic flow were calculated as follows:

Mach number M=3.2

Density

$$\rho = \frac{\rho_o}{\left(1 + \frac{k-1}{2} M^2 \right)^{1/(k-1)}} \qquad \text{(eqn 3.2)}$$

Static temperature

$$T = \frac{T_o}{\left(1 + \frac{k-1}{2} M^2 \right)} \qquad \text{(eqn 3.3)}$$

Static pressure

$$P = \frac{P_o}{\left(1 + \frac{k-1}{2} M^2 \right)} \qquad \text{(eqn 3.4)}$$

Sonic velocity

$$c = (k R T)^{1/2} \qquad \text{(eqn 3.5)}$$

Velocity in z direction

$$w = c M \qquad \text{(eqn 3.6)}$$

In addition to the quantities above for the turbulent flow case turbulent kinetic energy terms and dissipation terms were specified as follows:

Turbulent kinetic energy

$$k = 0.01\ w^2 \qquad \frac{\text{Joule}}{\text{kg}} \qquad \text{(eqn 3.7)}$$

Dissipation term

$$\varepsilon = 0.16\ k^{\left(-\frac{1.5}{2\ GH}\right)} \qquad \frac{\text{Joule}}{\text{kg}} \qquad \text{(eqn 3.8)}$$

where GH is the thickness of the TVC vane.

C. BOUNDARY CONDITIONS

1. Boundary Conditions at the Upstream and Downstream Sides

For laminar flow at the low side of the computational domain, mass flux, velocity in the flow direction, and enthalpy were specified.

For the turbulent flow problem, in addition to the boundary conditions above the turbulent kinetic energy and dissipation terms were specified at the low and high side boundaries.

2. Boundary Conditions on the Wall

At the wall, normal and tangential velocities were set to zero. Enthalpy at the wall was given by using a wall function. Details of the wall functions will be given in the next section.

Using a wall function the heat transfer rate is evaluated from the Chilton-Colburn form of Reynolds analogy, in which the Stanton number (St) is related to the friction

coefficient (C_f) as follow:

$$St = C_f \, Pr^{-2/3} \qquad \text{(eqn 3.9)}$$

where Pr is the laminar Prandtl number. C_f is related to the wall shear stress (τ_w) and the velocity paralel to the wall (w) as follows;

$$C_f = \frac{\tau_w}{\rho \, w^2} \qquad \text{(eqn 3.10)}$$

$$\tau_w = \frac{\mu \, w}{\frac{\Delta y}{2}} \qquad \text{(eqn 3.11)}$$

where $\frac{\Delta y}{2}$ is the distance from the wall to the center of the first cell.

The heat transfer rate per unit area at the wall ($\dot{Q}''$) is then deduced from

$$\dot{Q}'' = St \; \rho \, w \, (h_p - h_w) \qquad \text{(eqn 3.12)}$$

where h_p is entalpy at the grid node and, h_w is enthalpy corresponding to the prescribed wall temperature

$$h_w = C_p \, T_w \qquad \text{(eqn 3.13)}$$

where C_p is constant pressure specific heat and T_w is the wall temperature

In the analysis of the laminar flow case, instead of activating the wall function, the velocity at the wall has been given as zero because of the no slip condition and the enthalpy at the wall has been given.

D. WALL FUNCTION

The wall problem in the numerical computation of flows, especially in turbulent flow, is an old one and most authors have adopted similar techniques. In effect they "bridge over" the region very close the wall, by introducing special functions which are called wall functions. These are often empirical in origin. Accounts may be found in the books by Gosman Et Al (1969) and Spalding (1975)

The problem arises as follows. Turbulence dies out, close to the wall, because no slip condition and the rigitidy of the wall make all the velocity components fall to zero. The consequence is that the effective viscosity and other transport properties, fall there to their laminar values and the result is a rapid variation with distance from the wall both of the ϕ's and of their gradients.

It is possible to compute these variations in detail, by using a computer code such as PHOENICS on two conditions:

(i) the grid points must be packed into the region of steep gradient changes closely enough for sufficient numerical accuracy to be obtained

(ii) the functions appearing in the turbulence model equations must properly represent the influences of local Reynolds number on turbulence

Under the conditions above, the wall function sequences in the program act as follows:

The Reynolds number is first evaluated, based on the resultant velocity paralel to the wall, on the distance from the wall to the grid node and on density and laminar viscosity. If this Reynolds number is less than 132.25 (the value at which the laminar and turbulent wall function intersect) a laminar wall function is used. If this Reynolds number turns out to be greater than 132.25 the velocity variation is logarithmic and the corresponding shear stress coefficient is evaluated. This corresponds to the commonly used "log law " wall function. [Ref. 4],

E. GRID SYSTEM

To obtain a fine grid resolution in the boundary layer for the laminar flow case the first five cells in the y direction from the wall obey the following proportionality relationship

$$BYFRAC(IY) = \left(\frac{IY}{5}\right)^3 \left(\frac{\Delta_{max}}{10\ GH}\right)$$

Where BYFRAC(IY) is the distance from the south side to the north side of the cell of particular interest, divided by total length of the domain, IY is the cell number, Δ_{max} is maximum allowable cell height, and GH is the thickness of the TVC jet vane.

A fine grid resolution for the turbulent flow case is set up in the same way as laminar flow. The Only difference comes from the selection of the first five cells in y direction. The Following calculation shows the difference.

from the laminar solution and given properties the following are known.

w=885.2 m/s

$\mu_{lam}=1*10$ N. s/m

Po=5.5*10^6 Pa

Pstatic=1.048*10^5 Pa

k=1.35

ρ=1.835 kg/m

Using the values above and the lenght of vane, which is 0.095m, A corresponding Reynolds number was calculated:

$$Re_x = \frac{\rho_\infty w_\infty x}{\mu_{lam}} = \frac{(1.835 * 888.5 * 0.095)}{1 * 10^{-5}} = 1.54 * 10^6$$

Using power law expressions

$$\frac{\delta}{z} = 0.37 * Re_z^{-1/5} \qquad \text{(eqn 3.14)}$$

From equation 3.14 the boundary layer thickness at the high end of the domain have been calculated as $\delta \approx 2 * 10^{-3}$ m

With Re based on w_∞ the velocity paralel to the wall, $\frac{\Delta y}{2}$ the distance from the wall to the first grid node, ρ_∞ the density, and μ_{lam} the laminar viscosity. Δy must satisfy the condition

$$Re_z = \frac{\frac{\rho_\infty}{2} w_\infty \Delta y}{\mu_{lam}} \geq 132.25 \quad \text{or} \quad \Delta y \geq 6.48 * 10^{-6} \text{m}$$

Therefore the interval of Δy is chosen such that

$$2 * 10^{-3} \text{m} \geq \Delta y \geq 6.48 * 10^{-6} \text{m}$$

In this effort using the relationship

$$\text{BYFRAC(IY)} = \left(\frac{IY}{5} \right)^2 \left(\frac{\Delta_{max}}{10\ GH} \right)$$

Δy has been calculated as $\Delta y = 8 * 10^{-5}$ m which is in the required interval.

For both laminar and turbulent cases, cells in the z direction were adjusted so that the points where possible physical phenomena such as shock wave and expansion fan are expected, very fine cells were generated. In the other parts of the domain larger cells were generated. In this effort the grid system was made up of 25 cells in the y direction and 22 cells in the z direction. The grid system for laminar and turbulent flow is shown in Figure 3.3 and in Figure 3.4

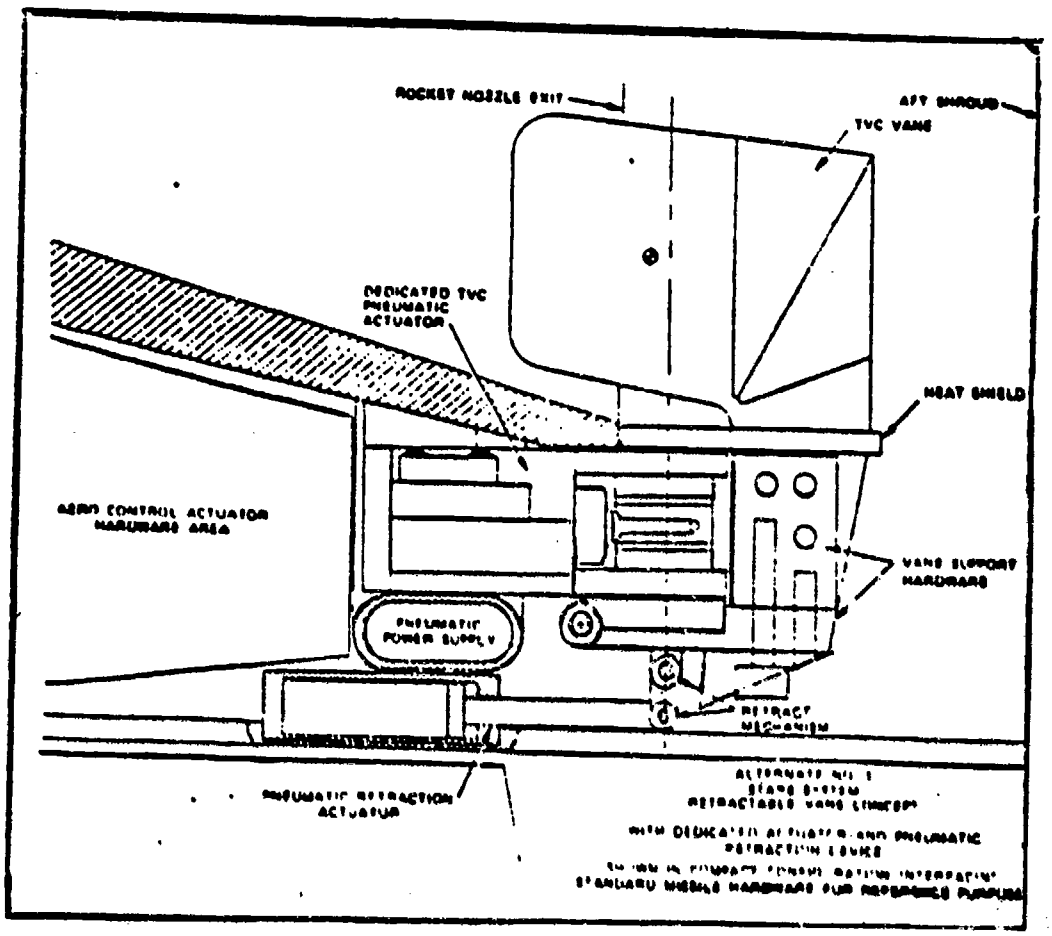

Figure 3.1 General Configuration of a TVC System.

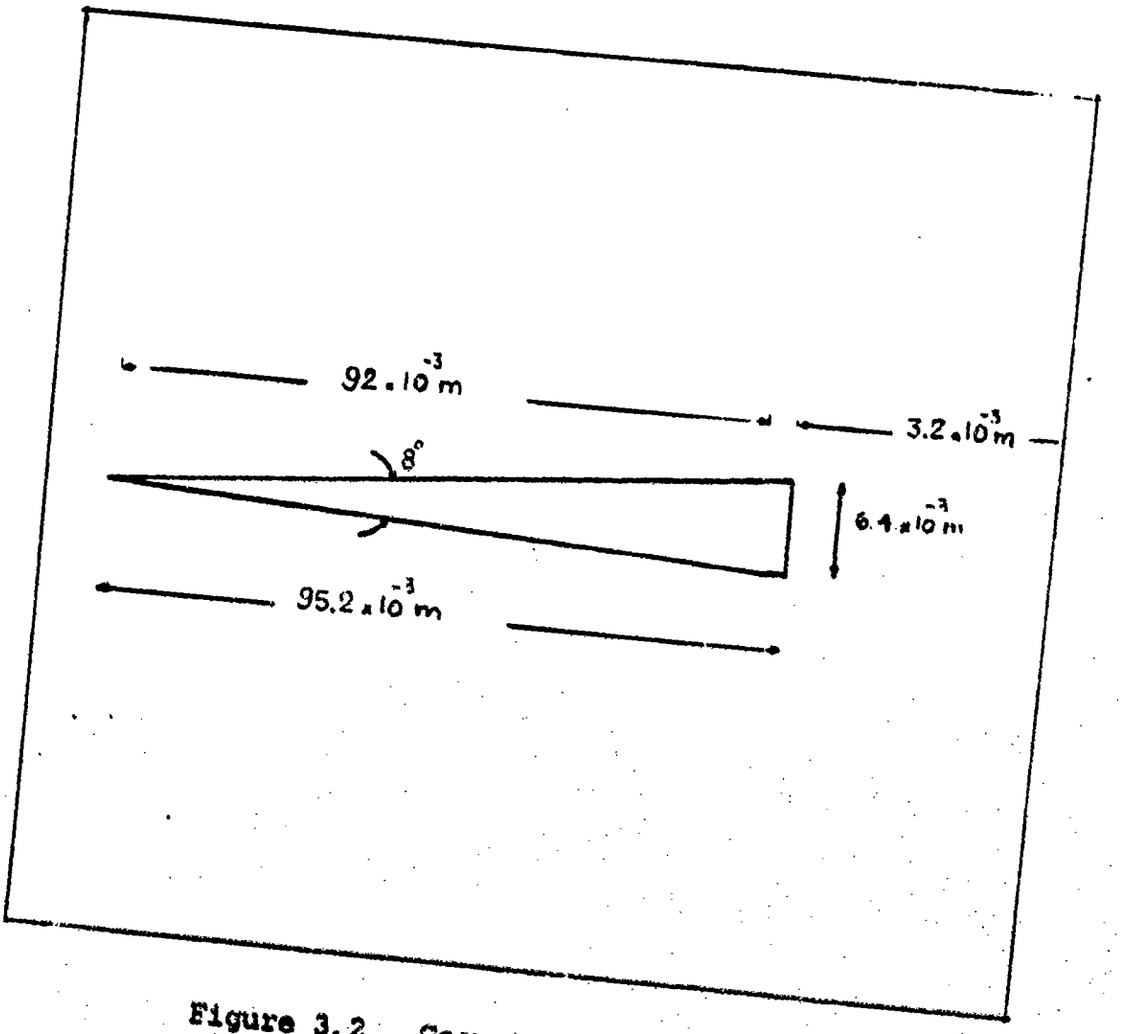

Figure 3.2 Geometry Used in the Model.

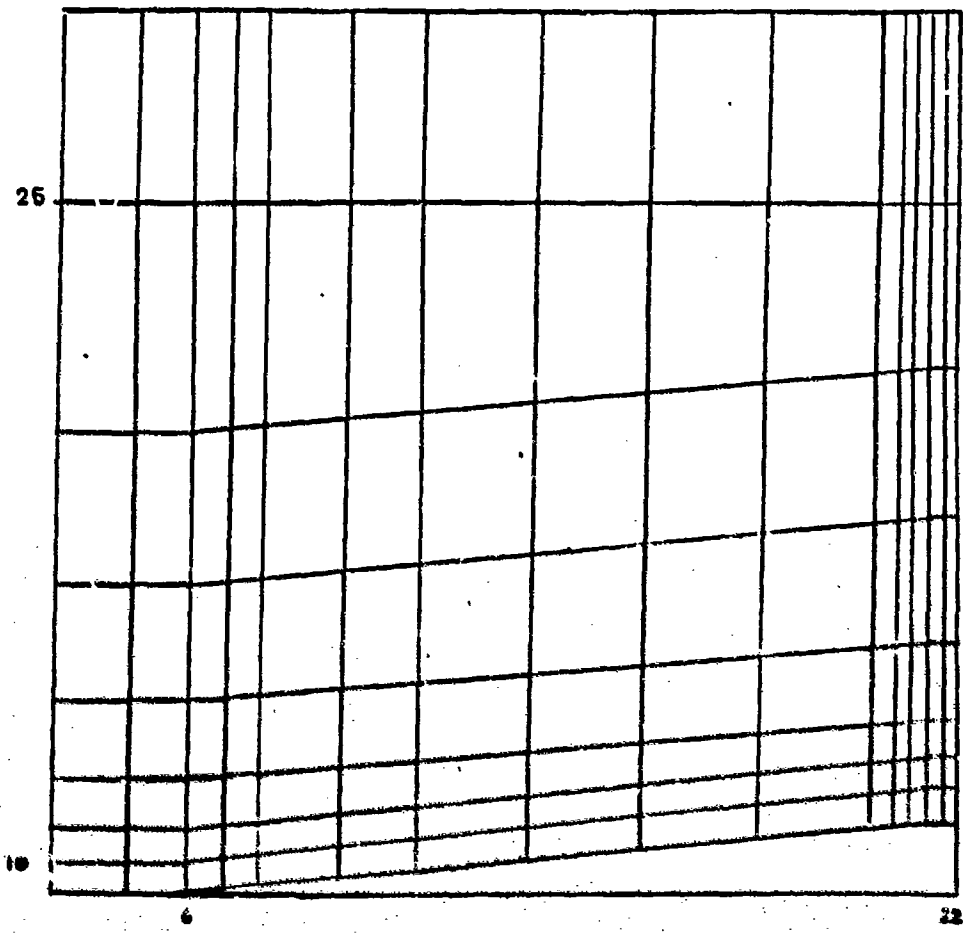

Figure 3.3 Grid System for Laminar Flow.

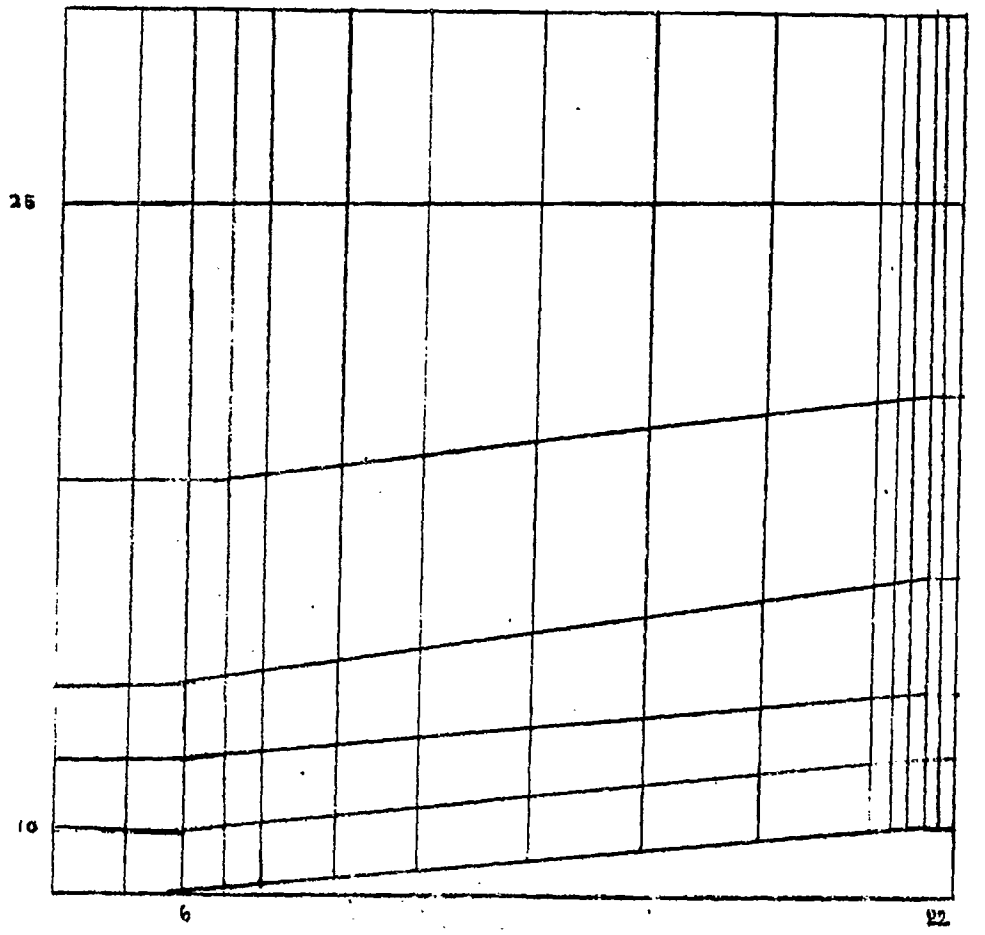

Figure 3.4 Grid System for Turbulent Flow.

IV. DISCUSSION ON QUANTITATIVE DISTRIBUTIONS

A. MACH NUMBER DISTRIBUTION

The expected oblique shock originates at the leading edge of the TVC vane. The shock angle was calculated using oblique shock theory as follows: [Ref. 6],

$$\tan\theta = \frac{2\cot\beta\,(M_1^2\sin\beta - 1)}{M_1^2\,(k + \cos(2\beta)) + 2} \qquad \text{(eqn 4.1)}$$

$$[\,M_1^2\,(k + \cos\beta) + 2\,]\tan\theta = 2\cot\beta\,(M_1^2\sin\beta - 1) \qquad \text{(eqn 4.2)}$$

where β is shock angle and θ is deflection angle (4 degree for this analysis).

Using equation 4.2 and equation 4.1 the shock angle has been calculated as β=20.99 degrees. To calculate the Mach number across the oblique shock, the following procedure has been followed.

$$M_{1n} = M_1 \sin\beta$$

where M is the normal Mach number immediately before the oblique shock

$$M_{2n}^2 = \frac{M_{1n}^2 + \frac{2}{k-1}}{\frac{2k}{k-1}M_{1n}^2 - 1} \qquad \text{(eqn 4.3)}$$

where k is k=1.35 and M_{2n} is the Normal Mach number after the oblique shock, from the equation above M_2 has been

calculated using the relationship

$$M_2 = \frac{M_{2n}}{\sin(\beta - \theta)} = 3.001 \qquad \text{(eqn 4.4)}$$

where M_2 is the Mach number after the oblique shock.

After obtaining the Mach distribution from the PHOENICS solution the points of

$$M = \frac{3.2 + 3.001}{2} \approx 3.1$$

in the domain have been plotted for the laminar and turbulent flow cases. Calculated slope angles of the oblique shock lines for both laminar and turbulent cases are 20.7° and 21° degrees.

The reason for selection of Mach number of M=3.1 points in the computational domain is to take into account the uncertainities between the starting and ending limits of oblique shock phenomenon.

The pressure ratio is calculated using the relation

$$\frac{P_2}{P_1} = \frac{2k}{k+1} M_1^2 - \frac{k-1}{k+1} \qquad \text{(eqn 4.5)}$$

Therefore p_2/p_1 has been calculated as $\frac{P_2}{P_1} = 1.36$

and p_2 has been calculated as $P_2 = 1.36\ P_1 = 1.426 * 10^5$ Pa

To take into account uncertainities an average pressure value has been calculated as follows:

$$P = \frac{(1.048 + 1.426) * 10^5}{2} = 1.237 * 10^5 \text{ Pa}$$

Investigating the locations where $P=1.237*10^5$ Pa in the computational regime corresponding points have been found, the same as the points corresponding to M=3.1 points. From the calculations above the location of the oblique shock has been presented in figures 4.1, 4.2, and 4.3

B. SKIN FRICTION DISTRIBUTION

1. Laminar Skin Friction Distribution

From the incompressible Blasius solution [Ref. 4], skin friction coefficient is:

$$C_f = \frac{0.664}{(Re_z)^{1/2}} \qquad \text{(eqn 4.6)}$$

Figure 4.5 shows the C_f distribution according to the Blasius solution.

Applying pressure and viscosity correction factors to the incompressible Blasius solution, the following form of the Blasius solution is obtained. [Ref. 4],

$$C_f = 0.664 \left(\frac{P\,C_w}{Re_z}\right)^{1/2} \qquad \text{(eqn 4.7)}$$

where $P = \frac{\rho}{\rho_e}$, $C_w = \frac{\mu}{\mu_e}$

This corrected skin friction distribution is shown in Figure 4.6

Using the PHOENICS flow field output, C_f has been calculated as follows.

$$C_f = \frac{\tau_w}{\frac{1}{2} \rho w_\infty^2} \qquad \tau_w = \frac{\mu w}{\frac{\Delta Y}{2}}$$

Figure 4.7 shows the C_f distribution from this procedure.

Comparison of three C_f vs z graphs in figure 4.8 shows that, the solution for laminar flow over the vane is consistent with the Blasius solution in terms of general tendency. The jump in PHOENICS solution near the downstream end of the vane occured because of the geometry change from the inclined part of the vane to the flat part of the vane. Other deviations from the general tendency comes from the numerical instabilities in PHOENICS.

2. Turbulent Skin Friction Coefficient Distribution

For comparison of the turbulent skin friction coefficient distribution, a flat plate solution has been used.

C_f for a flat plate, assuming incompressible flow is [Ref. 4],

$$C_f = \frac{0.455}{\ln^2 0.06\, Re_z} \qquad \text{(eqn 4.8)}$$

Relation between $(C_f)_{comp}$ and $(C_f)_{inc}$ is [Ref. 7],

$$\frac{(C_f)_{comp}}{(C_f)_{inc}} = \frac{1}{1 + r \frac{k-1}{2} M_\infty^2} \qquad \text{(eqn 4.9)}$$

where r denotes the recovery factor which for turbulent flow is $r=Pr^{1/3}$ [Ref. 7],

Calculated result of $\frac{(C_f)_{comp}}{(C_f)_{inc}}$ ratio is 0.4

Therefore the compressible skin friction coefficient C_f can be written as

$$(C_f)_{comp} = \left(\frac{0.455}{\ln^2 0.06\, Re_z}\right) * 0.4 \qquad \text{(eqn 4.10)}$$

The Corresponding C_f vs z distribution is given in Figure 4.9

Figure 4.1 shows the relationship between $\frac{(C_f)_{comp}}{(C_f)_{inc}}$ and Mach number M which is taken from [Ref. 4],

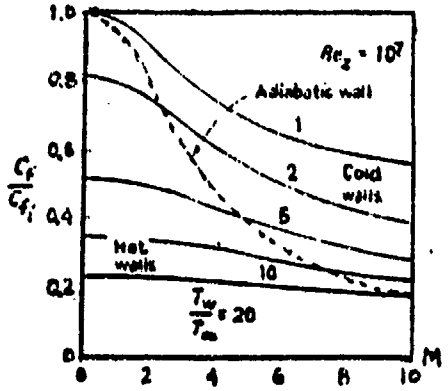

Figure 4.1 Cf ratio vs M graph.

Entering the Figure 4.1 for $\frac{T_w}{T_\infty} = 1.623$ and $M = 3.2$, $\frac{(C_f)_{comp}}{(C_f)_{inc}}$ has been obtained as $\frac{(C_f)_{comp}}{(C_f)_{inc}} = 0.77$

Applying this correction factor to equation 4.8 and using this updated equation for the C_f calculations the corresponding graph in Figure 4.10 has been obtained.

In the calculations using PHOENICS flow field, the following relation has been used.

$$C_f = \frac{2}{w_\infty^2} \frac{\rho_w}{\rho_\infty} \frac{k_w}{3.33} \qquad \text{(eqn 4.11)}$$

To obtain equation 4.11, turbulent kinetic energy equation has been used as a starting point. [Ref. 5],

$$\rho \frac{Dk}{Dt} = \frac{\partial}{\partial Y} \left(\frac{\mu_T}{\sigma_k} \frac{\partial k}{\partial Y} \right) \qquad \text{(eqn 4.12)}$$

$$+ k \left[\frac{\mu_T}{k} \left(\frac{\partial u}{\partial Y} \right)^2 - C_D \frac{\rho^2 k}{\mu_T} \right]$$

The Source term of the turbulent kinetic energy equation should be zero near the wall which means

$$\frac{\mu_T}{k} \left(\frac{\partial u}{\partial Y} \right)_w^2 - C_D \frac{\rho^2 k}{\mu_T} = 0 \qquad \text{(eqn 4.13)}$$

therefore the shear stress on the wall can be defined as:

$$\tau_w = C_D^{1/2} \rho_w k_w \qquad \text{(eqn 4.14)}$$

where k_w is the turbulent kinetic energy on the wall, ρ_w is the density on the wall and C_D is $C_D = 0.09$ [Ref. 5], Substituting the values above into the Blasius skin friction relation the C_f equation becomes:

$$C_f = \frac{2 \tau_w}{\rho_\infty w_\infty^2} = \frac{\rho_w}{\rho_\infty} \frac{2}{w_\infty^2} \frac{k_w}{3.33} \qquad \text{(eqn 4.15)}$$

Using this equation a C_f vs z graph in Figure 4.11 has been plotted.

Comparison of those three graphs in Figure 4.12 shows that a general consistency in tendency can be observed. The jump in the PHOENICS solution comes from the geometrical change of the vane, as in the laminar flow case. The other deviation from the general tendency comes from the numerical instabilities of PHOENICS.

C. LAMINAR HEAT TRANSFER DISTRIBUTIONS

In the laminar flow analysis the heat flux has been calculated using an equation as follows for every cell over the surface of the vane.

$$Q'' = \frac{\mu}{Pr} * \frac{h_p - h_w}{\frac{\Delta Y}{2}} \qquad \text{(eqn 4.16)}$$

where h_p is the enthalpy at the grid node, h_w is the enthalpy at the wall and $\frac{\Delta Y}{2}$ is the distance from the grid node to the wall.

Equation 4.16 has been obtained using the following procedure.

$$Q'' = k \frac{\partial T}{\partial Y} = \frac{\mu}{\frac{\mu C_p}{k}} * \frac{h_p - h_w}{\frac{\Delta Y}{2}} = \frac{\mu}{Pr} * \frac{h_p - h_w}{\frac{\Delta Y}{2}}$$

The corresponding heat flux distribution is shown in Figure 4.13

The Stanton numbers have been calculated by using the heat flux calculations. The Stanton number equation is

$$St = \frac{Q''}{\rho_\infty w_\infty (0.9 h_0 - h_w)} \qquad \text{(eqn 4.17)}$$

The denominator of equation 4.17 has been obtained from the following relation between the recovery temperature and stagnation temperature [Ref. 6],

$$\frac{T_r}{T_o} = \frac{1 + r\left(\frac{k-1}{2}\right) M_\infty^2}{1 + \left(\frac{k-1}{2}\right) M_\infty^2} = 0.928 \qquad \text{(eqn 4.18)}$$

where Tr is recovery temperature, To is stagnation temperature and r is recovery factor which for laminar flow is $r=Pr^{1/2}$. This gives

$$\frac{T_r}{T_o} = \frac{h_r}{h_o} = 0.9 \quad \text{and} \quad h_r = 0.9\, h_o$$

therefore

$$St = \frac{q''}{\rho_\infty w_\infty (h_r - h_w)} = \frac{q''}{\rho_\infty w_\infty (0.9\, h_o - h_w)}$$

where h_r is the recovery enthalpy and h_o is the stagnation enthalpy. The distribution of Stanton number is shown in Figure 4.14

Using the definition of Stanton number, the heat transfer coefficient has been calculated.

$$H = \rho_\infty w_\infty St\, C_p \qquad \text{(eqn 4.19)}$$

and the H distribution over the surface has been plotted in Figure 4.15

D. TURBULENT HEAT TRANSFER DISTRIBUTION

In the turbulent analysis taking advantage of following skin friction correlation; $C_f = \frac{2\, \rho_w\, k_w}{w^2_\infty\, \rho_\infty\, 3.33}$

The Stanton numbers has been calculated using the Colburn analogy.

$$St = \frac{C_f}{2} \left(Pr \right)^{-2/3} \qquad \text{(eqn 4.20)}$$

Stanton number distribution is shown in Figure 4.16 Using the calculated Stanton numbers. The heat transfer coefficient distribution has been calculated from

$$H = \rho_\infty w_\infty St C_p \qquad \text{(eqn 4.21)}$$

Heat transfer coefficient distribution is shown in Figure 4.17 From heat transfer coefficient values, heat flux distribution has been calculated:

$$Q'' = \frac{H}{C_p} \left(0.928 h_0 - h_w \right) \qquad \text{(eqn 4.22)}$$

This equation has been obtained from the following procedure. [Ref. 8],

$$Q'' = \rho_\infty w_\infty St \left(h_r - h_w \right) \qquad \text{(eqn 4.23)}$$

substituting for Stanton number, gives

$$Q'' = \frac{H}{C_p} \left(h_r - h_w \right) \qquad \text{(eqn 4.24)}$$

Using equation 4.18, equation 4.24 yields;

$$Q'' = \frac{H}{C_p} \left(0.928\, h_o - h_w \right) \qquad \text{(eqn 4.25)}$$

A Graph of the heat flux distribution is given in Figure 4.18

The corresponding computer programs and tabular distribution values have been included in appendices for both laminar and turbulent flow solutions.

E. DISCUSSION ON CPU TIME

Comparison of the laminar and turbulent solution in terms of cpu time can be seen on the next table. The values below have been evaluated for the same continuity error of $7.416*10^{-4}$ and 100 "sweeps". Continuity error implies the residual error of mass imbalance for the particular cell which has been used as a control cell and "sweep" implies a sequence of iterative steps through the integration domain.

TABLE I
CPU TIME COMPARISON

	TOTAL CPU TIME
LAMINAR SOLUTION	147 seconds
TURBULENT SOLUTION	188 seconds

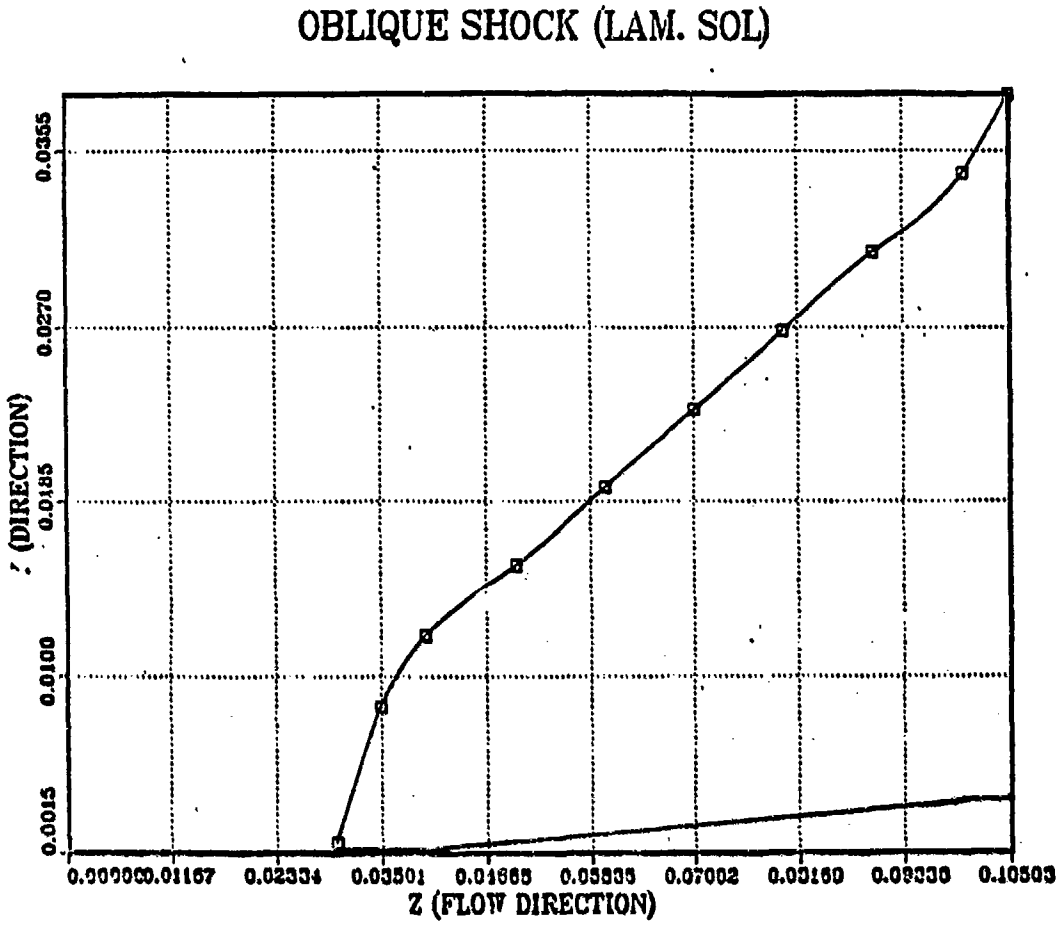

Figure 4.2 Location of Oblique Shock in Laminar Flow.

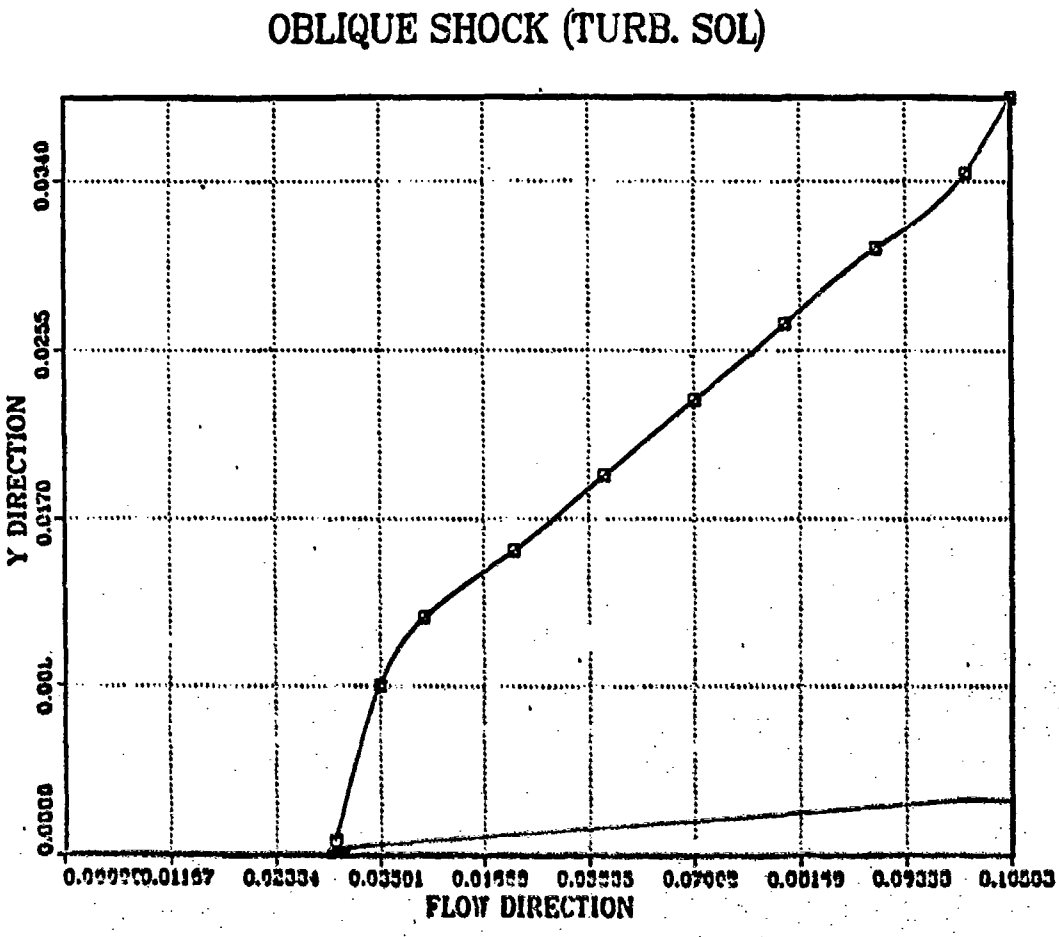

Figure 4.3 Location of Oblique Shock in Turbulent Flow.

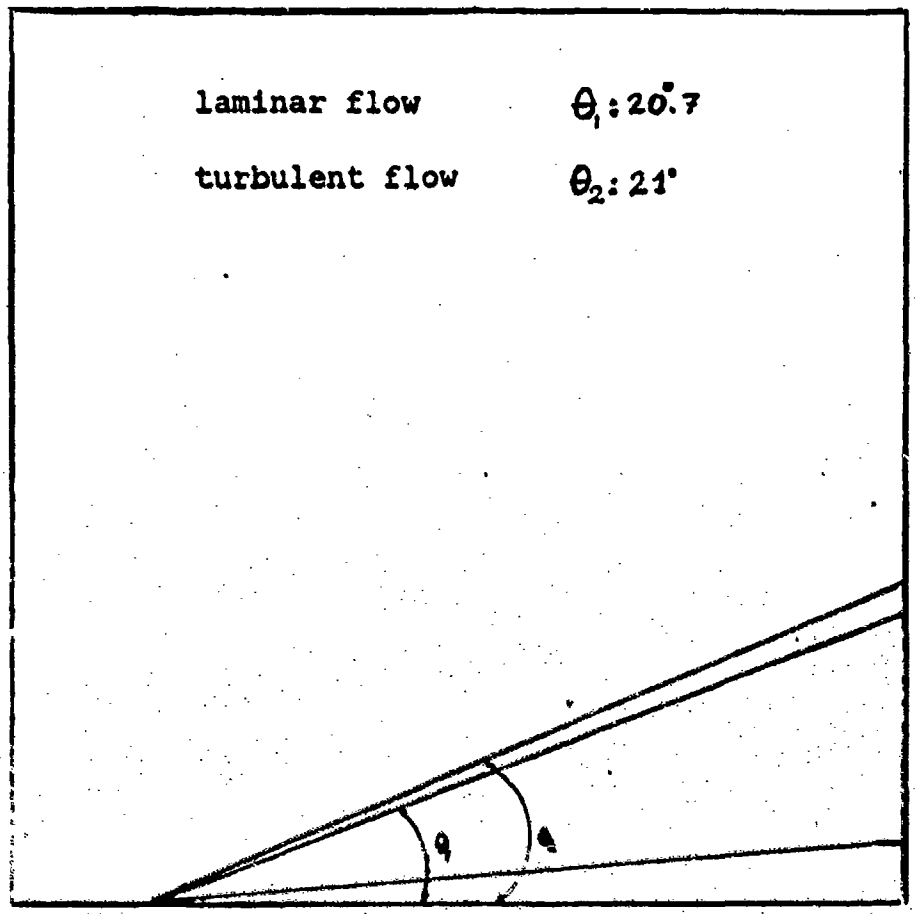

Figure 4.4 Oblique Shock Relative to Vane.

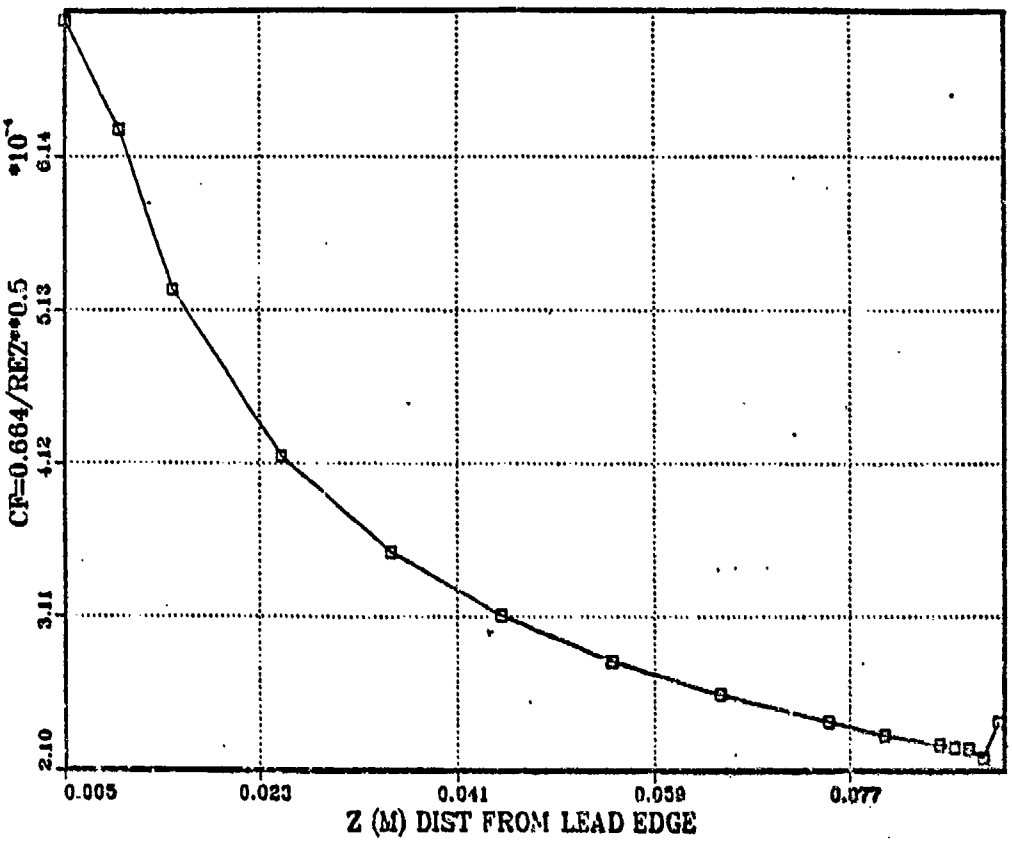

Figure 4.5 Laminar Flat Plate Solution.

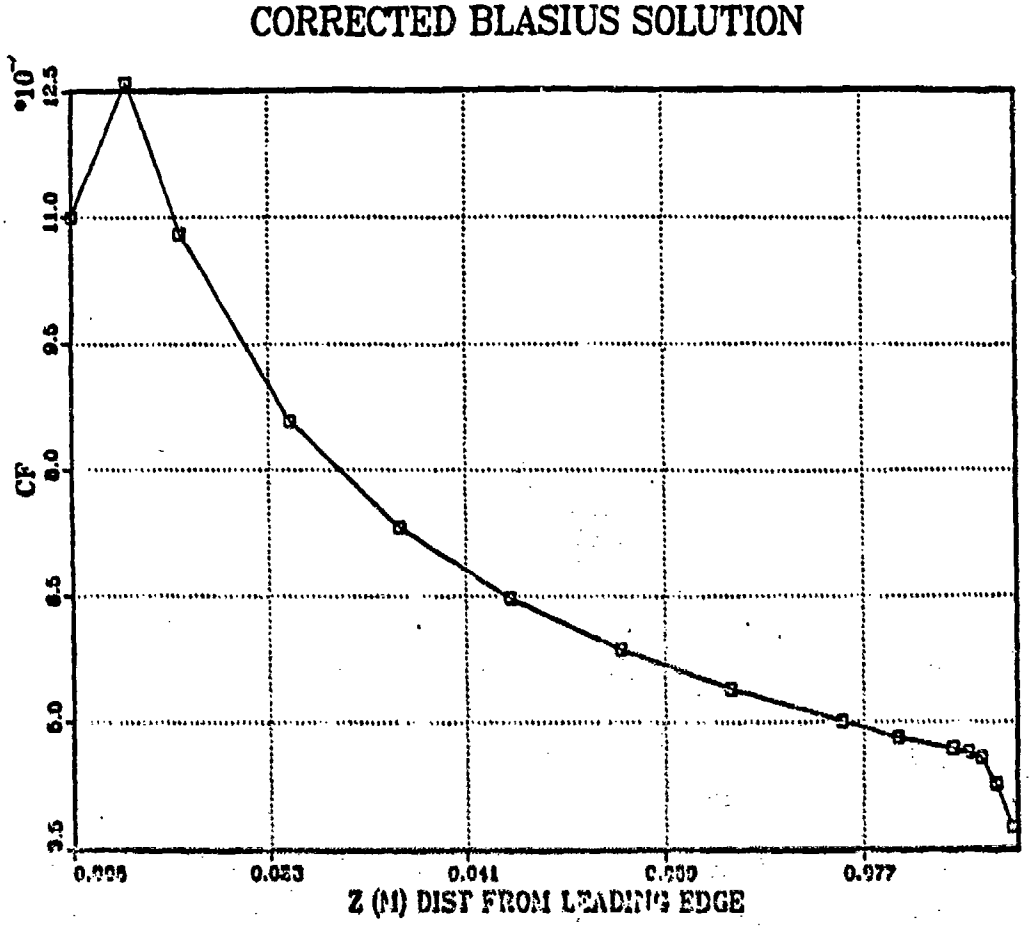

Figure 4.6 Laminar Blasius (Corrected) Solution.

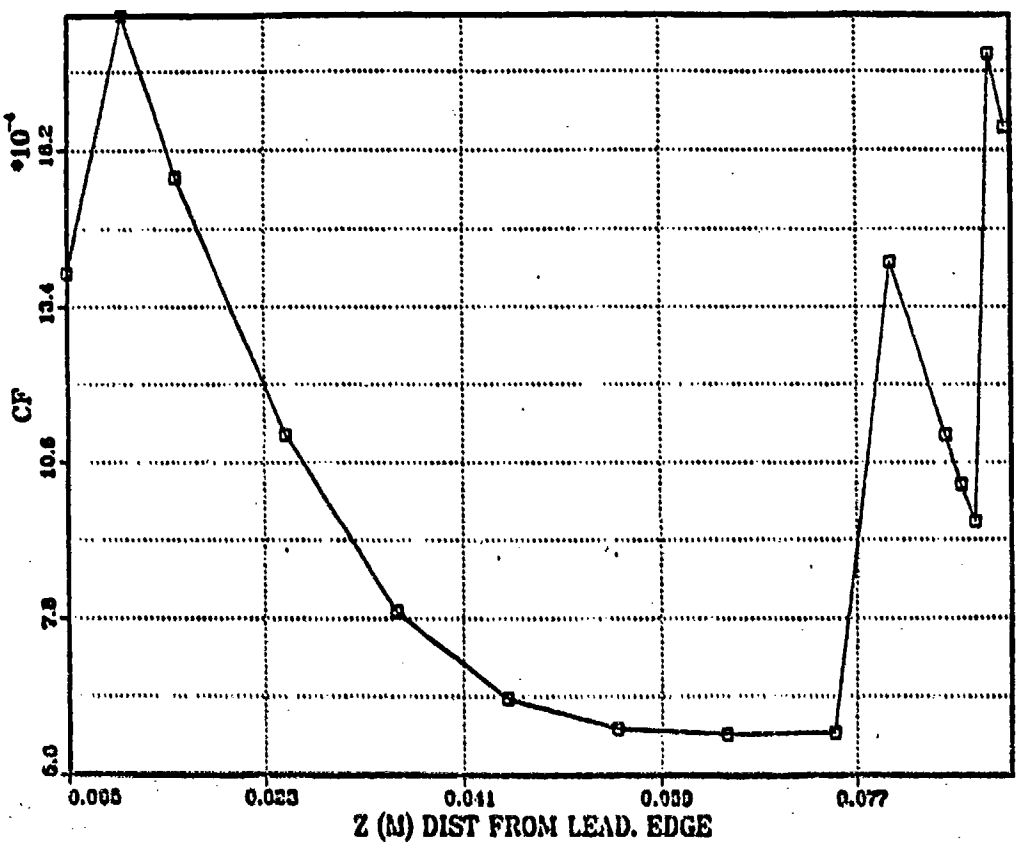

Figure 4.7 Laminar (Phoenics) Solution.

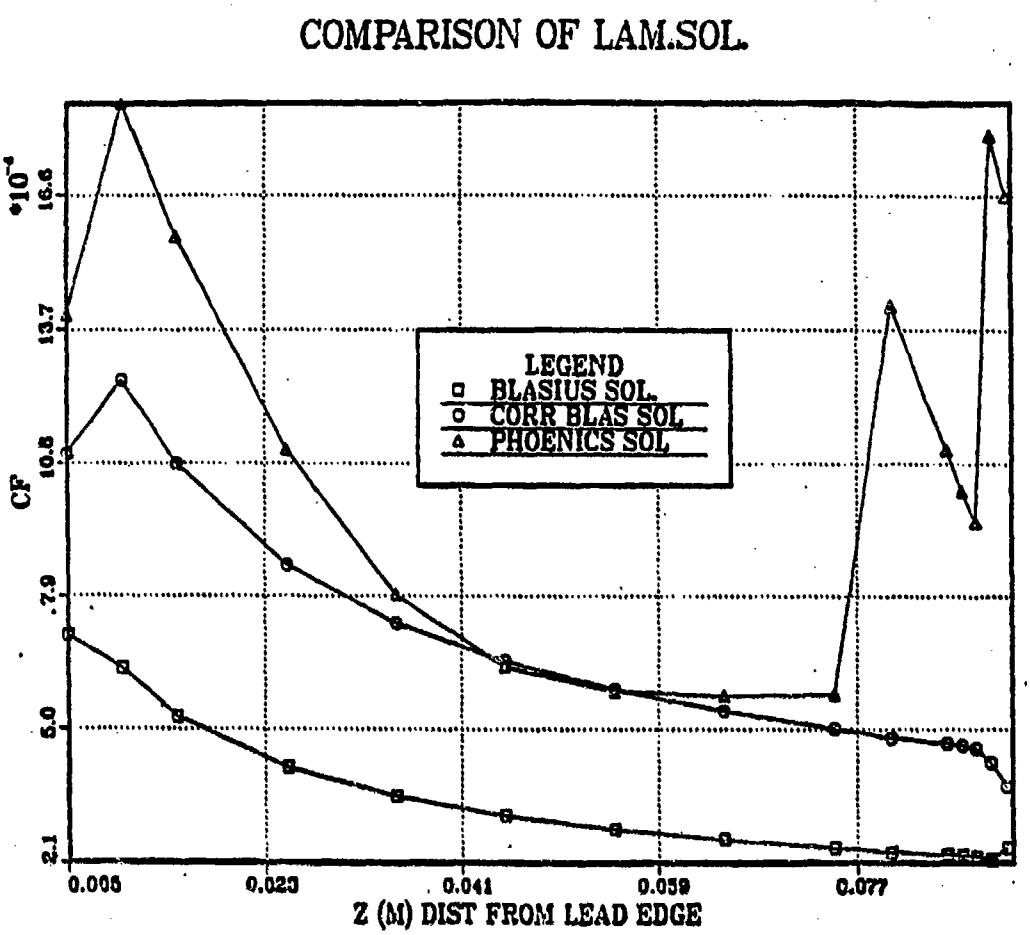

Figure 4.8 Comparison of Laminar Solutions.

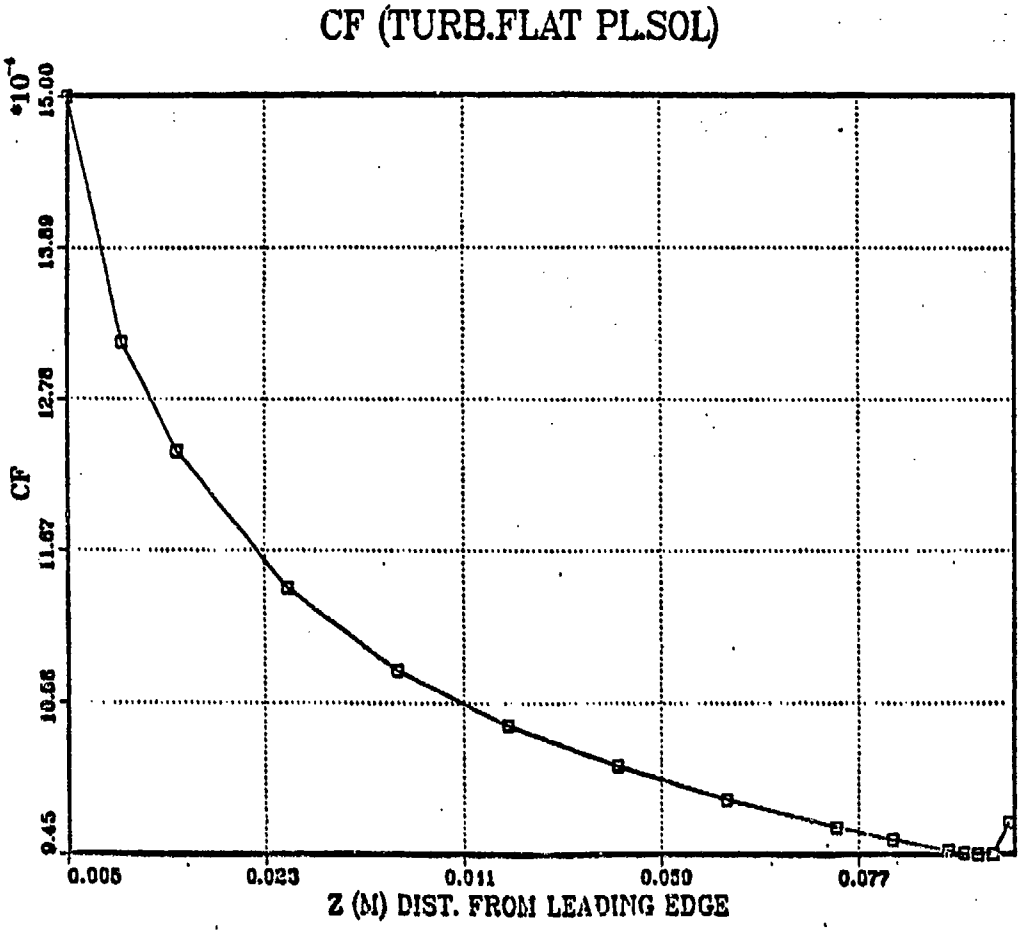

Figure 4.9 Turbulent Flat Plate Sol..

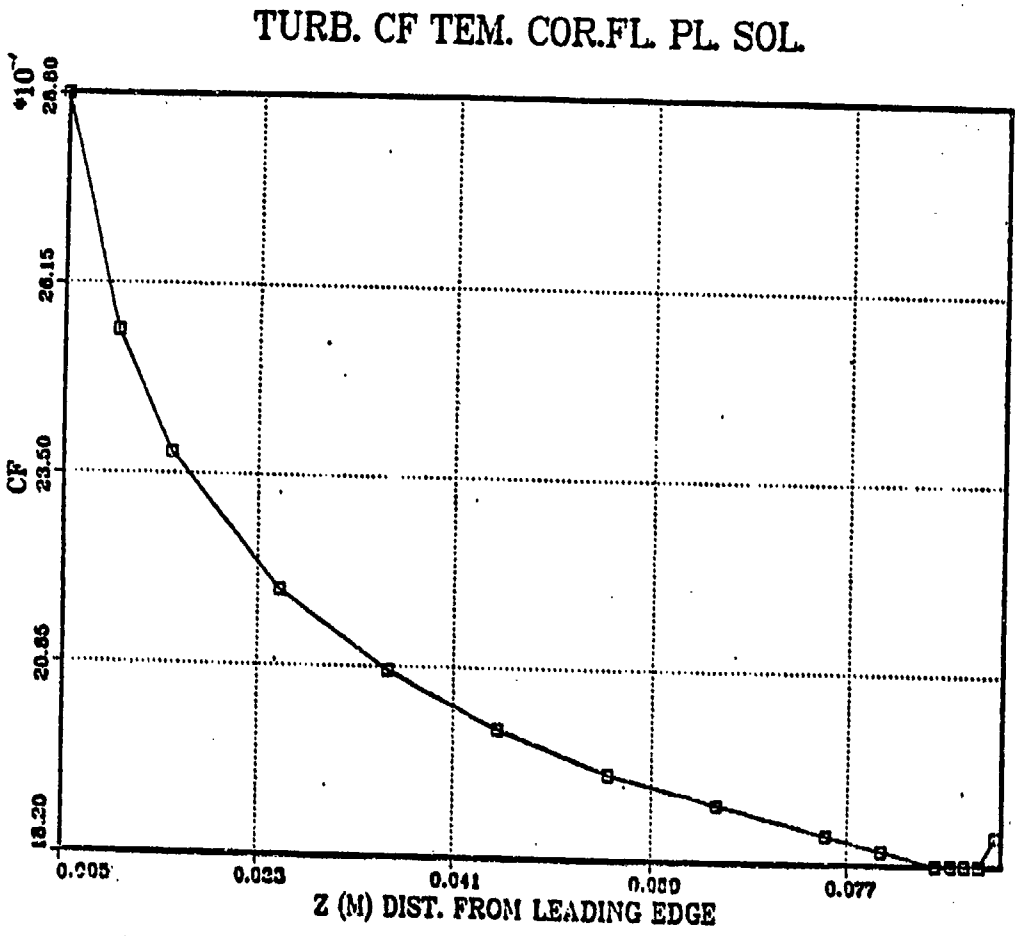

Figure 4.10 Turbulent Flat Plate (Corrected) Sol.

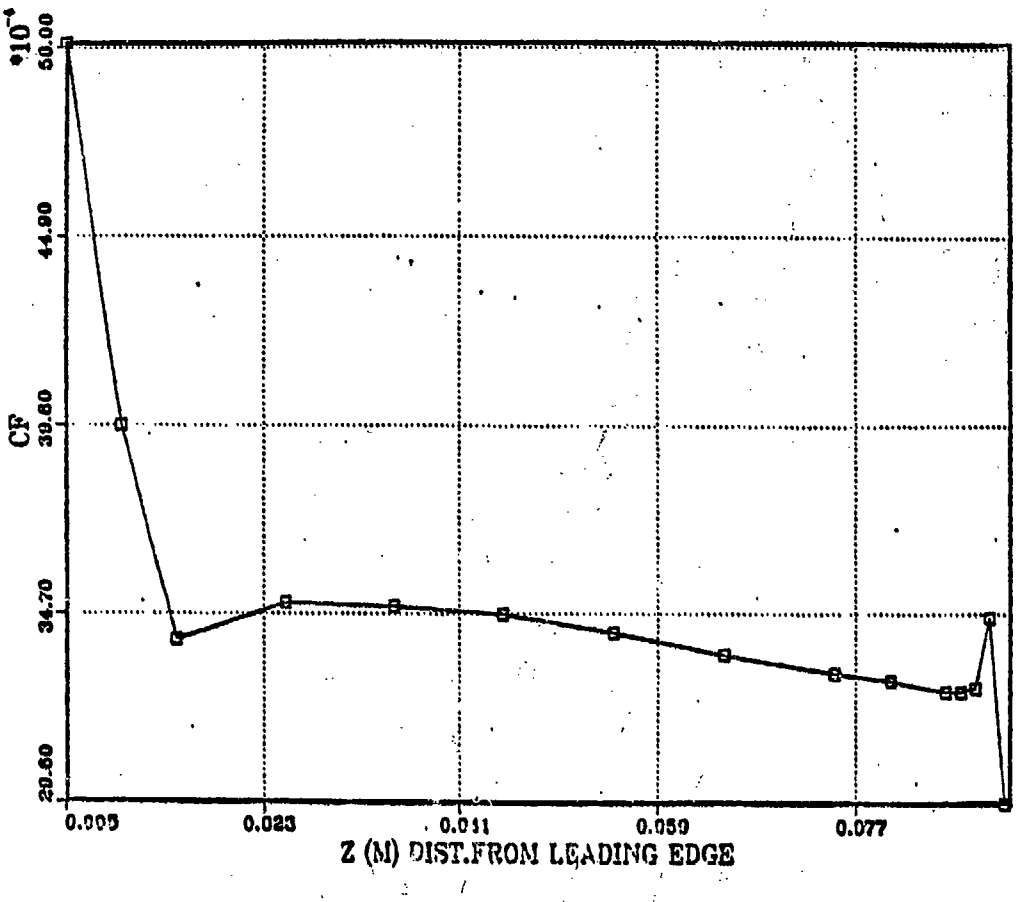

Figure 4.11 Turbulent Solution (Phoenics).

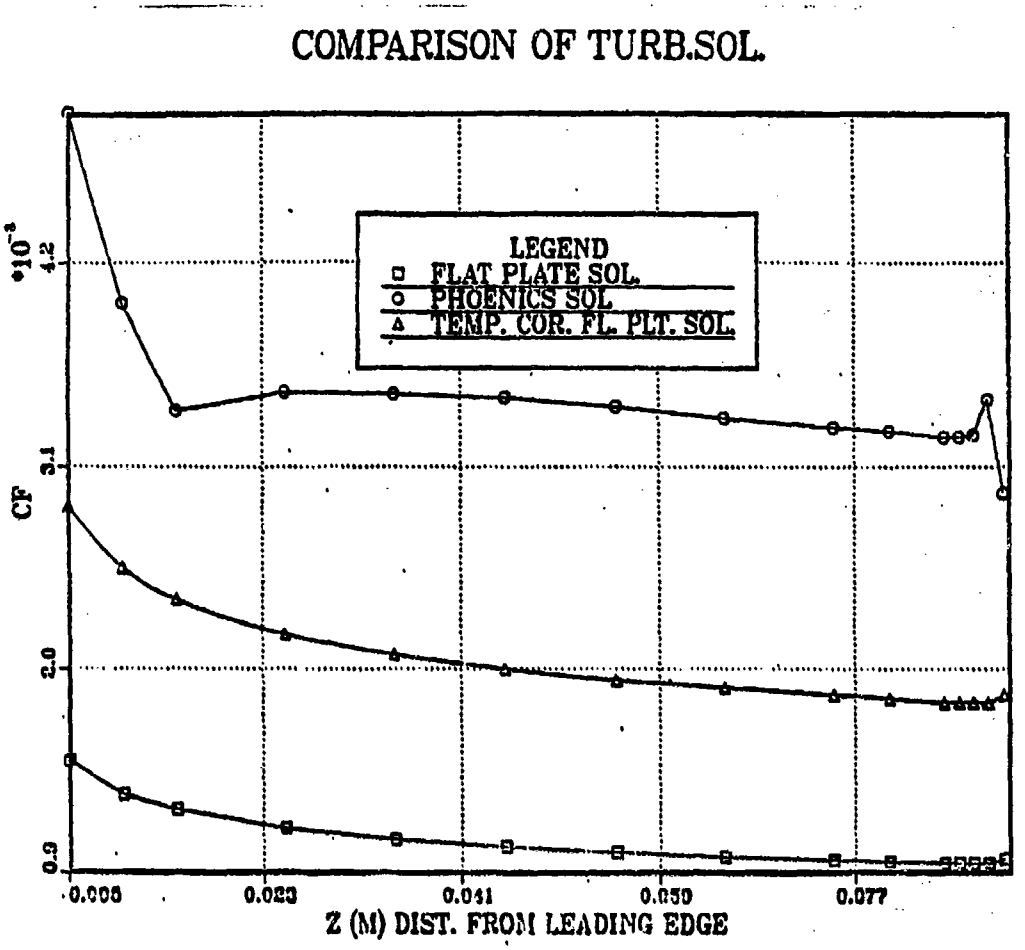

Figure 4.12 Comparison of Turbulent Solutions.

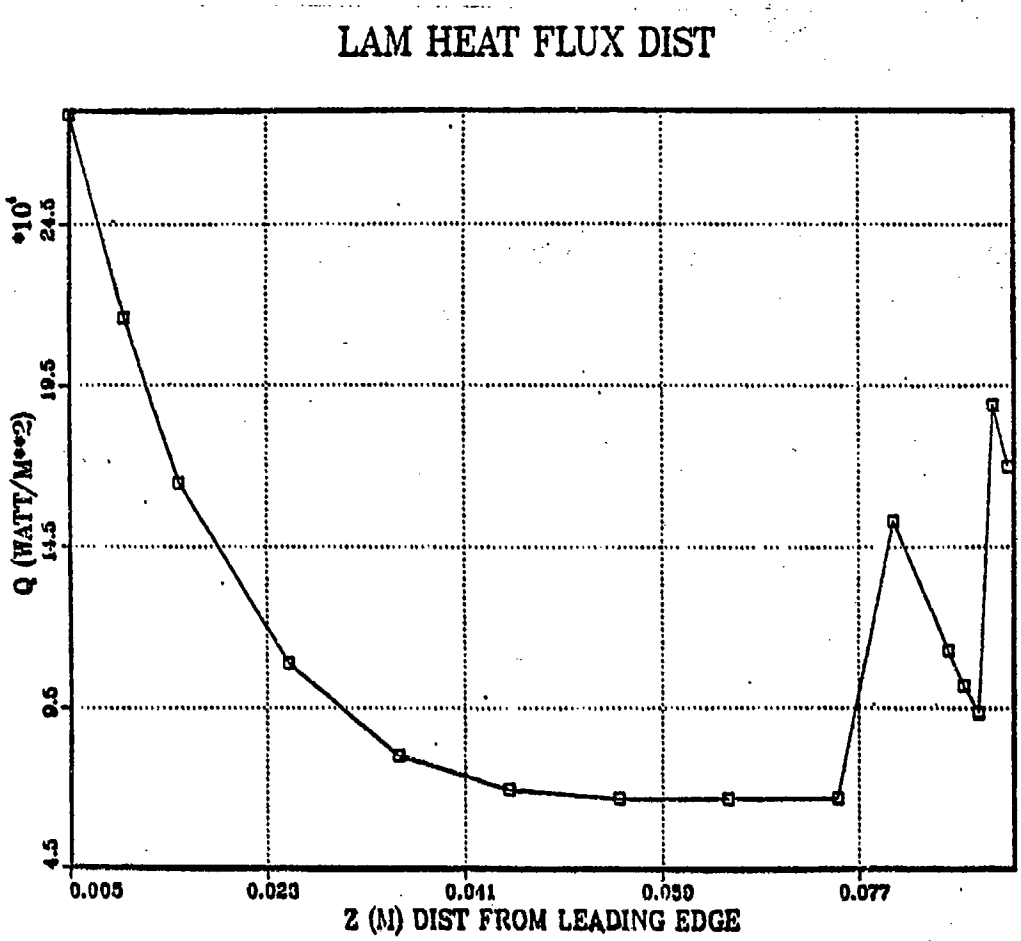

Figure 4.13 Laminar Heat Flux Distribution..

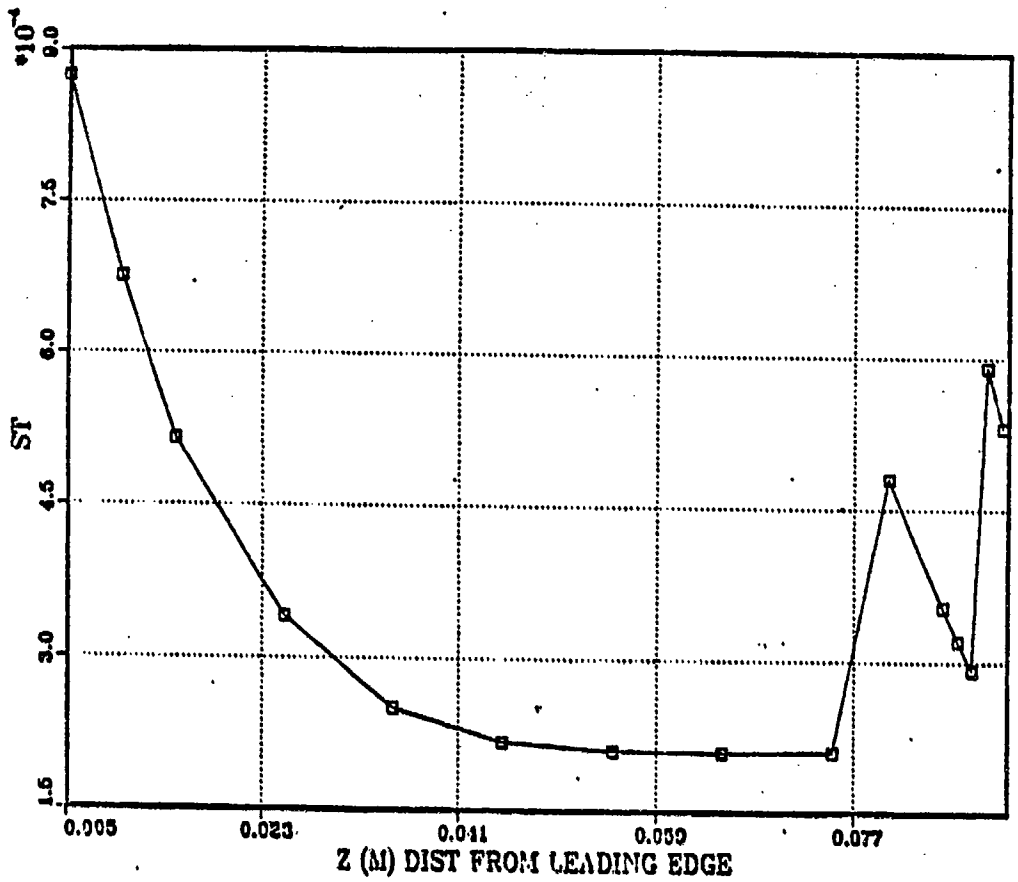

Figure 4.14 Laminar Stanton Number Distribution..

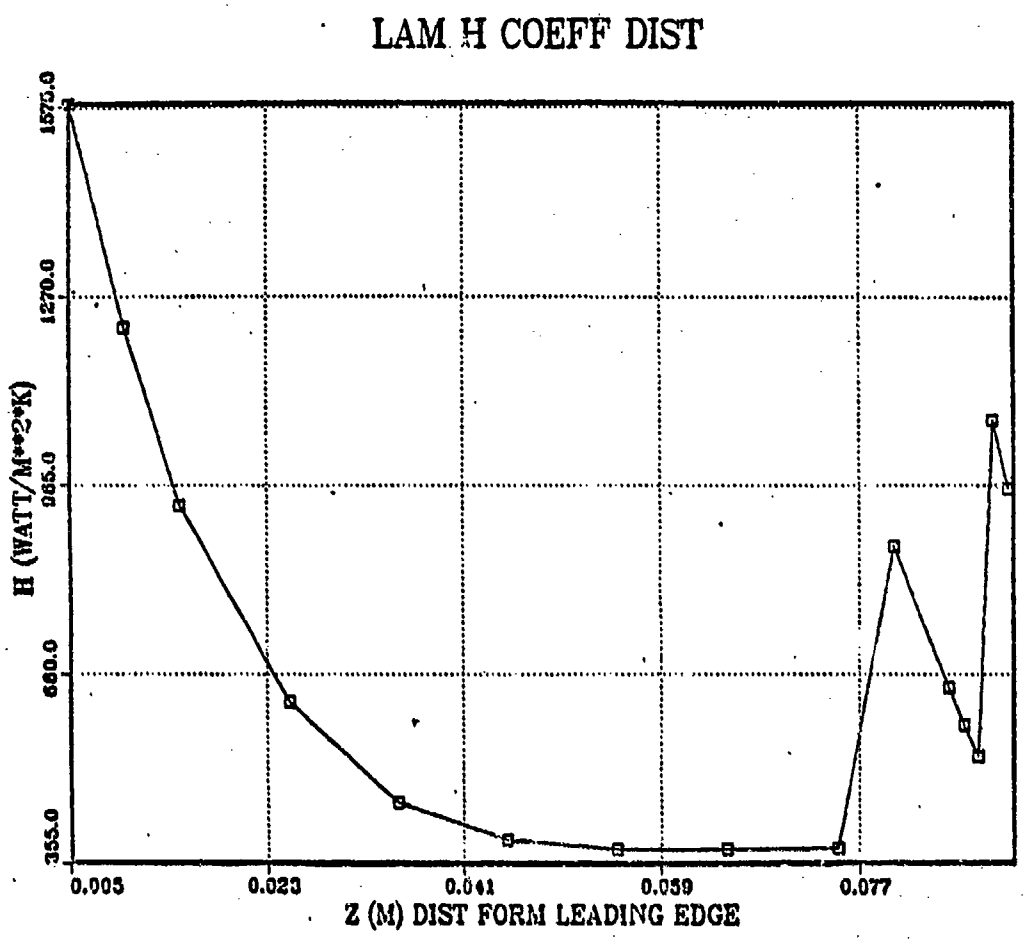

Figure 4.15 Laminar H Coeff. Distribution..

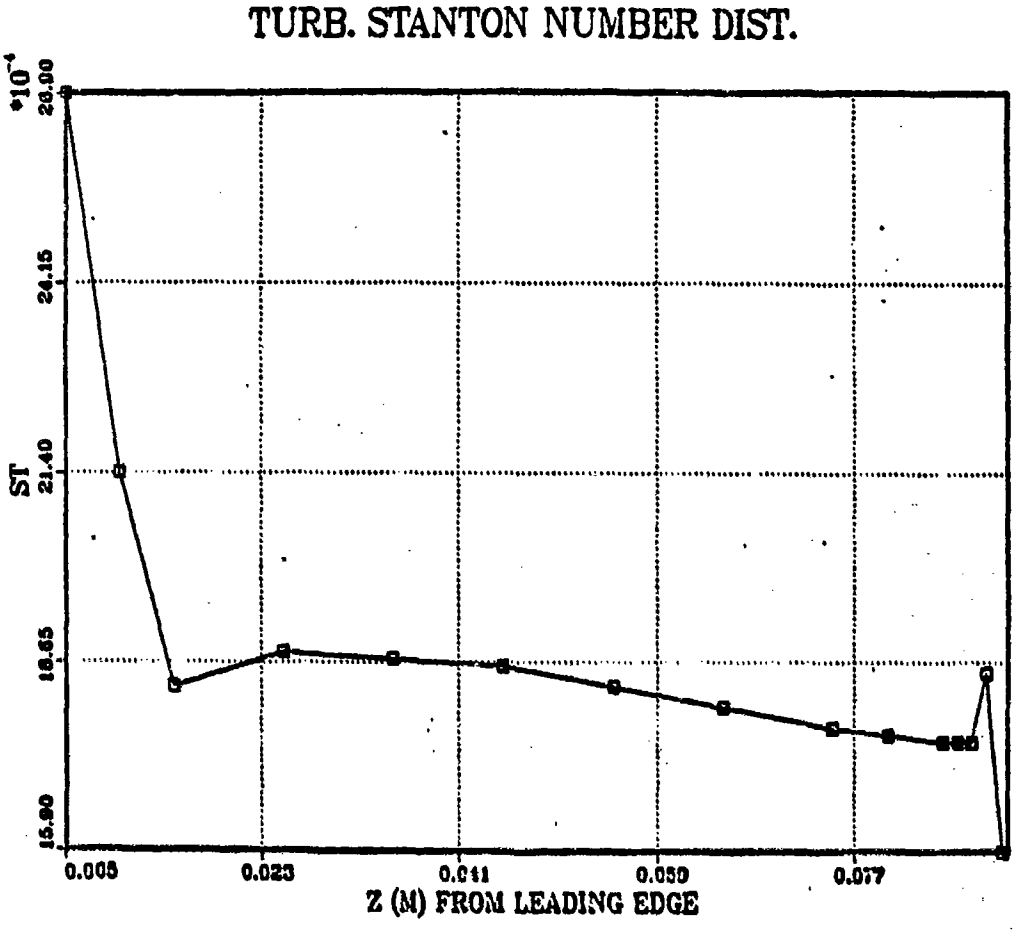

Figure 4.16 Turbulent Stanton Number Distribution.

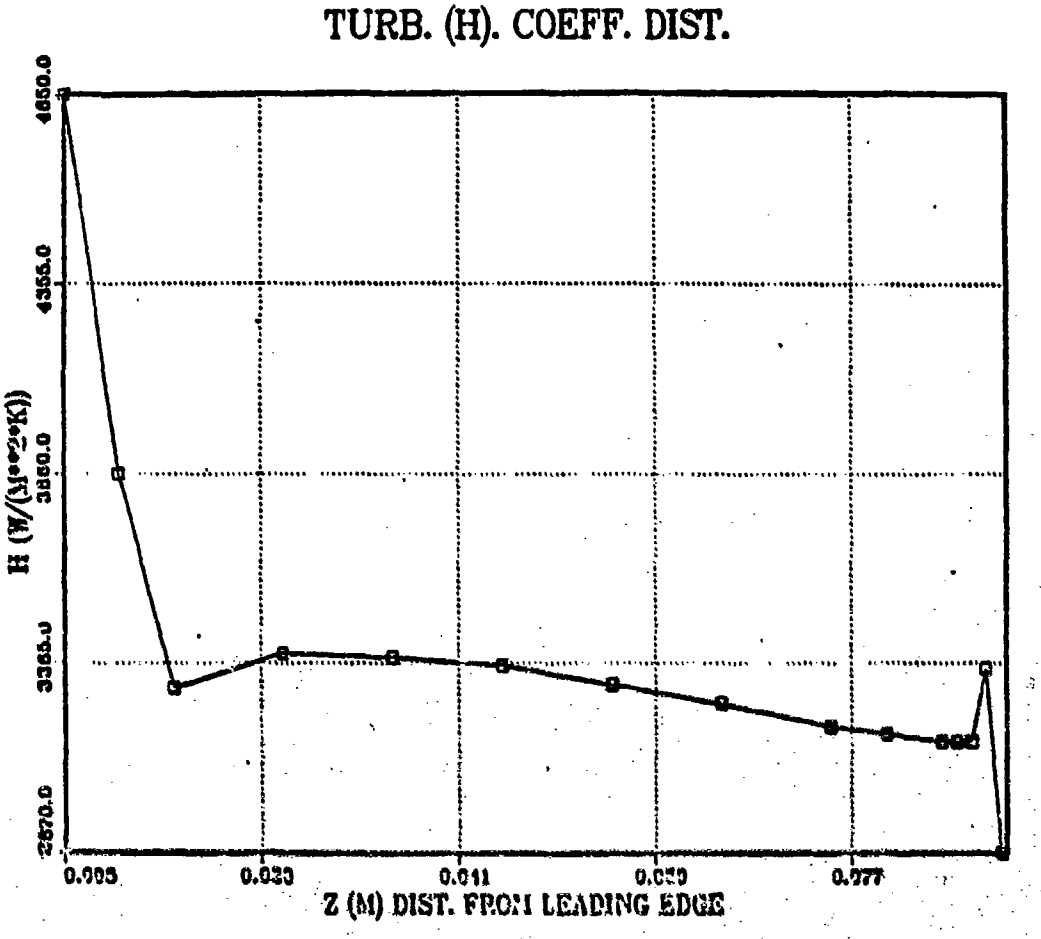

Figure 4.17 Turbulent H Coeff. Distribution..

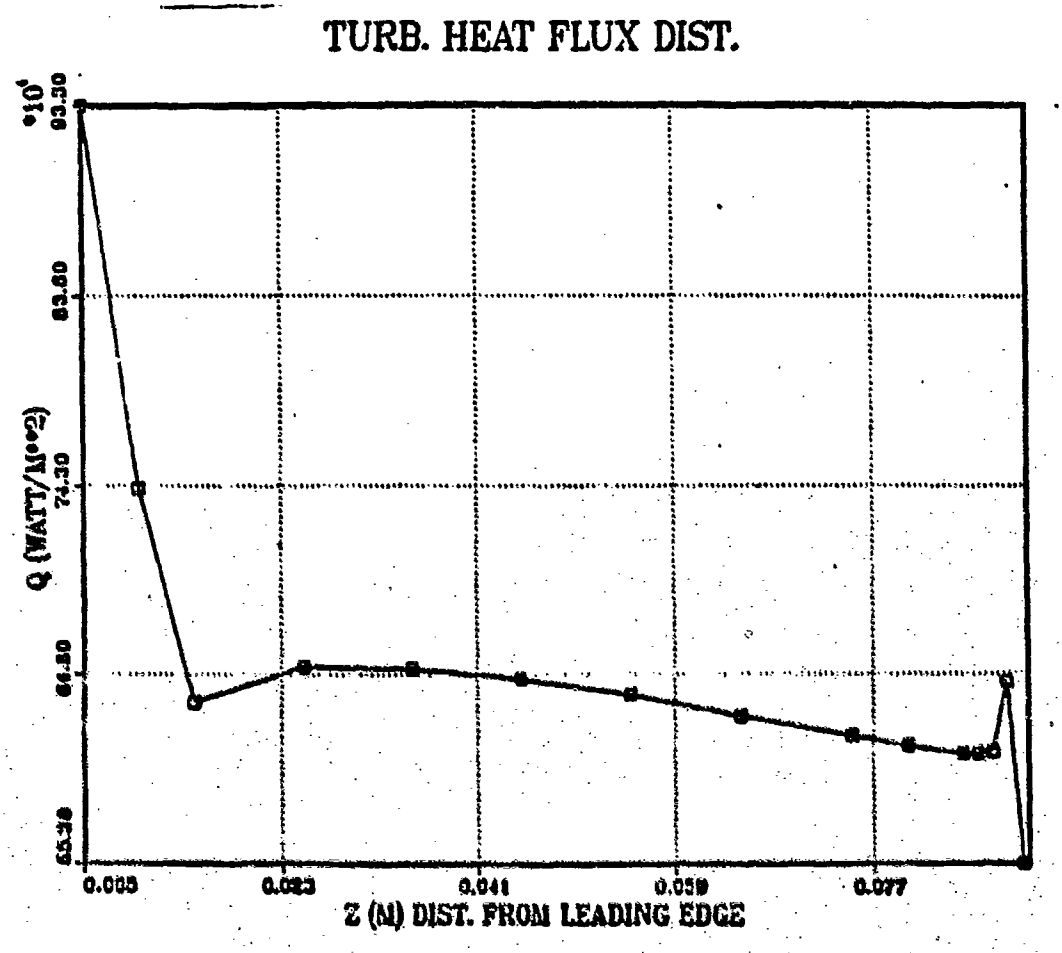

Figure 4.18 Turbulent Heat Flux Distribution..

V. CONCLUSION AND RECOMMENDATION

The PHOENICS solution approach to this problem showed that the turbulent case is more grid resolution sensitive than the laminar case. The reason for this difference is the requirement for the wall function in the turbulence model.

As explained in Chapter III the operation of the wall function depends on the evaluation of a particular Reynolds number. This Reynolds number is based on the resultant velocity parallel to the wall evaluated one grid spacing from the wall. This value is then checked to use the laminar or turbulent wall function. Since turbulence dies out close to the wall, grid dimensions in y direction should be selected such that, at least three grids should remain in the boundary layer, but they should be far enough from the wall.

The wedge geometry of the model used in this study has a 4 degree inclined part and a flat part. Since there are no an analytical or experimental results to compare the results of this analysis with, the flat plate solutions have been used as a criterion, for both laminar and turbulent flow cases.

APPENDIX A

SATELLITE PROGRAM OF PHOENICS USED IN LAMINAR ANALYSIS

```
C$DIRECTIVE**SATLIT
C.     SATELLITE PROGRAM OF PHOENICS IN LAMINAR FLOW ANALYSIS
C      NZ=22 NY=25 YN=10*GH
C     *FILE NAME: MODBFCST.FTN
C     *ABSTRACT: SATELLITE MODEL MAIN PROGRAM. THIS VERSION IS
C      FOR USE WITH THE BODY-FITTED COORDINATE SCHEME (SUMMER 1984
C      VERSION) PROVIDED AS AN ATTACHMENT TO SPRING 1983 PHOENICS.
C     *DOCUMENTATION: PHOENICS INSTRUCTION MANUAL (SPRING 1983)
C      WITH BODY-FITTED COORDINATES INSTRUCTION SUPPLEMENT
C      (SUMMER 1984).
C     *AUXILIARY SUBROUTINES (TAPES, ETC.) ARE IN SATELLITE LIBRARY
C      SERVICEU, WHICH MUST BE INCLUDED IN LINK EDIT TO RUN.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 1 STARTS:
C-----------------------------------------------------------------
CHAPTER 1   COMMON BLOCKS AND USER'S DATA.
C-----------------------------------------------------------------
      INCLUDE (CMNGUS)
       INCLUDE (CMNGRF)
      INCLUDE (GUSSEQ)
      COMMON/CPI/IPWRIT,IDUM(243)
      DIMENSION GDTAPE(3),DFAULT(4)
      DIMENSION ARRAY1(309),ARRAY2(194),ARRAY3(421)
      LOGICAL ARRAY1,LSPDA,WRT,RD,NAMLST
      INTEGER ARRAY2,XPLANE,YPLANE,ZPLANE
      INTEGER P1,PP,U1,U2,V1,V2,W1,W2,R1,R2,RS,EP,H1,H2,H3,C1,C2,
     &C3,C4
      REAL NORTH,LOW
      LOGICAL BFC
      EQUIVALENCE (ARRAY1(1),CARTES),(ARRAY2(1),NX)
      EQUIVALENCE (ARRAY3(1),SPARE1(1)),(M1,R1),(M2,R2)
```

```
      EQUIVALENCE (LSTRUN,INTGR(12)),(NAMLST,LOGIC(88))
      EQUIVALENCE (LOGIC(20),BFC)
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 1 ENDS.
C$DIRECTIVE**CMNBF1$$
C  THIS FILE CONTAINS SATELLITE COMMON BLOCKS FOR BFC'S
C  F1 MUST BE DIMENSIONED TO GREATER THAN OR EQUAL TO
C (NX+NY+17*NZ+24*NX*NY+6*(NX+1)*(NY+1)+6*ND). THE VALUE
C  OF THE DIMENSION MUST BE SET AS NBFC IN GROUP 6 OF SATLIT.
      COMMON/FOB/F1(5000)
      COMMON/CIB/ND/CIC/KOORD
      COMMON/CID/KDBGG,KDBGMF,KDBGCD,KDBIND,KDBMFX,KDBCDT,KDBPCS,
     &           KDBGUV,KDBGPV
      COMMON/CIE/KDBGS,KDBINS
      COMMON/CIF/IGEN/CIG/NCART
C  THE FOLLOWING ARRAYS MUST BE EXACTLY DIMENSIONED FOR NXP1,
C  NYP1 AND NZP1, BUT MAY BE OVER DIMENSIONED FOR ND.
C  THE BFRAC ARRAYS MUST BE DIMENSIONED TO ALLOW FOR SETTINGS
C  IN SATLIT, THEY MAY BE OVER DIMENSIONED.
      COMMON/CRA/XW(26,23,1)/CRB/XE(26,23,1)
     &      /CRC/YS(2,23,1)/CRD/YN(2,23,1)
     &      /CRE/ZL(2,26,1)/CRF/ZH(2,26,1)
     &      /CRG/RCON/CRH/DARCY/CRI/BXFRAC(99)/CRJ/BYFRAC(99)
     &      /CRK/BZFRAC(99)
      COMMON/CLA/STORSA(6),STORWD(6),STORP,STORPE,STORPN,
     &           STORPH,STOR1,STOR2,STOR3,STOUNV,PRTBFC,STOCRN
      COMMON/CLC/BFPLOT
      LOGICAL STORP,STORPE,STORPN,STORPH,STOR1,STOR2,STOR3,
     &        STORSA,STORWD,STOUNV,PRTBFC,BFPLOT,STOCRN
C     END
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 1 STARTS:
C     GRAFFIC ARRAYS DIMENSIONED AS NEEDED...
      COMMON/GRAF1/PHI1(1) /GRAF2/PHI2(1)
C     POROSITY & SPECIAL DATA ARRAYS DIMENSIONED AS NEEDED...
      DIMENSION PE(1,1,1),PN(1,1,1),PH(1,1,1),PC(1,1,1)
      DIMENSION LSPDA(1),ISPDA(1),RSPDA(1)
```

```
C     USER PLACES HIS VARIABLES, ARRAYS, EQUIVALENCES ETC. HERE.
      EQUIVALENCE(RAIR,RE(21)),(GAMA,RE(22)),(GSWP,RE(23))
C     USER PLACES HIS DATA STATEMENTS HERE.
      DATA NLSP,NISP,NRSP/1,1,1/
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 1 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 2 STARTS:
C-------------------------------------------------------------
CHAPTER 2   SET CONSTANTS, AND ARRANGE FILE MANIPULATIONS.
C-------------------------------------------------------------
C     PLEASE DO NOT ALTER, OR RE-SET, ANY OF THE REMAINING
C     STATEMENTS OF THIS CHAPTER.
      DATA CELL,EAST,WEST,NORTH,SOUTH,HIGH,LOW,VOLUME/
     & 0.,1.,2.,3.,4.,5.,6.,7. /
      DATA P1,PP,U1,U2,V1,V2,W1,W2,R1,R2,RS,KE,EP,H1,H2,H3,C1,C2,
     &C3,C4/1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20/
      DATA FIXFLU,FIXVAL,ONLYMS,WALL/1.E-10,1.E10,0.0,-10.0/
      DATA IPLANE,XPLANE,YPLANE,ZPLANE/0,1,2,3/
      DATA WRT,RD,DFAULT/.TRUE.,.FALSE.,4HDEFA,4HULT.,4HDTA/,1HG/
      DATA GDTAPE/4HGUSI,4HE1.D,2HTA/
      DATA NLDATA,NIDATA,NRDATA/309,194,421/
      DATA NLCREG,NTCVRG/60,350/
      DATA TITPP,TITC1,TITC2/3HRHO,4HMACH,4HTEMP/
      CALL TAPES(10,GDTAPE,3,1,4*NRDATA)
C-----------------------------READ DEFAULT FILE IF BLOCKDATA ABSENT
          IF(INTGR1(29).NE.10) GO TO 2
      CALL WRIT40(40HDATA ESTABLISHED IN BLOCK DATA.          )
      GO TO 3
    2 CALL DEFLT
CD  2 CALL TAPES(1,DFAULT,4,2,4*NRDATA)
CD    CALL DATAIO(RD,1)
      CALL WRIT40(40HDATA TAKEN FROM DEFAULT.DTA ON GROUP A/C)
    3 CALL WRIT40(40HFILE MODSTL.FTN IS THE SATLIT USED.      )
      LOGIC(89)=.TRUE.
C-------------------------------------------------------------
CHAPTER 3   DEFINE DATA FOR NRUN RUNS.
```

```
C-------------------------------------------------------------
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 2 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 2 STARTS:
C--- GROUP  41MULTI-RUNS : RUN(1-30)<.T.,29*.F.>
C
      RUN(1)=.FALSE.
C  NOTE: ALL RUNS ARE DEACTIVATED AT THIS POINT - USER SHOULD
C  ====  SWITCH ON ONE ONLY OF RUNS 1-4 IN NEXT STATEMENT.
      RUN(1)=.TRUE.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 2 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 3 STARTS:
        DO 10 IRUN=1,30
          IF(.NOT.RUN(IRUN)) GO TO 10
      NRUN=NRUN+1
      LSTRUN=IRUN
   10 CONTINUE
        DO 999 IRUN=1,LSTRUN
          IF(.NOT.RUN(IRUN)) GO TO 999
      INTGR(11) = IRUN
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 3 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 3 STARTS:
C---  ALL INTEGER VARIABLES ARE DEFAULTED TO 0, AND REAL VARIABLES
C     TO 0.0, UNLESS OTHERWISE INDICATED.
C     E.G. BY VARIABLE<10>, OR <10.0> AS APPROPRIATE.
C     THE DEFAULT SETTINGS OF ALL LOGICAL VARIABLES ARE ALWAYS
C     INDICATED, E.G. VARIABLE<.T.>, OR  VARIABLE<.F.>.
C
C---  RUN1
C-------------------    ---------------    -------------------
C---  GROUP 1. FLOW TYPE :
C     PARAB<.F.>,CARTES<.T.>,ONEPHS<.T.>
C-------------------    ---------------    -------------------
C---  GROUP 2. TRANSIENCE :
C     STEADY<.T.>,ATIME,LSTEP<1>,FSTEP<1>
C     TLAST<1.E10>,TFRAC(1-30)<30*1.>
```

```
C     SERVICE SUBROUTINE FOR 'NT' POWER-LAW TIME STEPS:
C     CALL GRDPWR(0,NT,TLAST,POWER)
C-------------------    --------------    ------------------
C---  GROUP 3. X-DIRECTION :
C     NX<1>,XULAST<1.0>,XFRAC(1-30)
C     SERVICE SUBROUTINE FOR POWER-LAW GRID:
C     CALL GRDPWR(1,NX,XULAST,POWER)
C-------------------    --------------    ------------------
C---  GROUP 4. Y-DIRECTION :
C     NY<1>,YVLAST<1.0>,YFRAC(1-30),RINNER,SNALFA
C     SERVICE SUBROUTINE FOR POWER-LAW GRID:
C     CALL GRDPWR(2,NY,YVLAST,POWER)
      NY=25
C-------------------    --------------    ------------------
C---  GROUP 5. Z-DIRECTION :
C     NZ<1>,ZWLAST<1.0>,ZFRAC(1-30)
C     SERVICE SUBROUTINE FOR POWER-LAW GRID:
C     CALL GRDPWR(3,NZ,ZWLAST,POWER)
      NZ=22
C-------------------    --------------    ------------------
C---  GROUP 6. MOVING GRID OR DISTORTED (BODY-FITTED) GRID :
C               --- MOVING GRID :
C     MGRID,IZW1,IZW2,AZW2,BZW2,CZW2,PINT,ZW2M1T
C-------------------------------------------------------------
C               --- BODY-FITTED GRID ---
C     BFC<.T.>,IGEN<1>,ND<1>,NBFC<5000>,KOORD,RCON
C     BXFRAC(1-NX)<1.0,NXM1*0.0>
C     BYFRAC(1-NY)<1.0,NYM1*0.0>
C     BZFRAC(1-NZ)<1.0,NZM1*0.0>
C     SERVICE SUBROUTINE FOR SUB-DOMAIN SPECIFICATION (FOR IGEN=1
C     ONLY):
C        CALL DOMAIN(ID,IXF,IXL,IYF,IYL,IZF,IZL)
C     XE(1-NYP1,1-NZP1,1-ND)<(NYP1*NZP1*ND)*1.0>,
C     XW(1-NYP1,1-NZP1,1-ND),
C     YN(1-NXP1,1-NZP1,1-ND)<(NXP1*NZP1*ND)*1.0>,
```

```
C     YS(1-NXP1,1-NZP1,1-ND),
C     ZH(1-NXP1,1-NYP1,1-ND)<(NXP1*NYP1*ND)*1.0>,
C     ZL(1-NXP1,1-NYP1,1-ND),STORSA(1-6)<6*.F.>,STORWD(1-6)<6*.F.>,
C     STORP<.F.>,STORPE<.F.>,STORPN<.F.>,STORPH<.F.>,STOUNV<.F.>,
C     PRTBFC<.F.>,DARCY,BFPLOT<.F.>
C     CYCLIC BOUNDARY CONDITIONS ARE DEFAULTED INACTIVE ;
C     TO ACTIVATE THEM AT SELECTED IZ SLABS USE SERVICE SUBROUTINE:
C        CALL XCYIZ(IZ,.TRUE.)
C     SERVICE SUBROUTINE TO DEACTIVATE CURVATURE TERMS IN U, V
C     AND W EQUATIONS ASSOCIATED WITH CURVATURE OF IX, IY, IZ
C     GRID LINES RESPECTIVELY:
C        CALL UCURVE(IZ,.FALSE.)
C        CALL VCURVE(IZ,.FALSE.)
C        CALL WCURVE(IZ,.FALSE.)
C     NCART<1>
C    *WARNINGS||||||
C     --------------
C       A) WHEN USING BFCS STOVAR(H3), STOVAR(C4), STOVAR(21) ARE
C          AVAILABLE ONLY FOR STORING NON-ORTHOGONAL VELOCITY
C          COMPONENTS.
C       B) MULTI-RUNS ARE NOT ALLOWED WITH BFC OPTION.
C       C) MOVING GRID,TWO-PHASE AND PARABOLIC OPTIONS ARE NOT
C          AVAILABLE WITH BFC OPTION.
C       D) KE-EP TURBULENCE MODEL SHOULD BE USED WITH BFC'S ONLY
C          WHEN THE MAIN FLOW IS IN THE IZ DIRECTION.
C       E) BUILT-IN GRAVITY TERMS DO NOT TAKE ACCOUNT OF BFC'S.
C    *NOTES
C     -----
C       A) THE STANDARD VELOCITY-FIELD PRINTOUT FOR THE
C          VELOCITY RESOLUTES IS ACTIVATED IN THE USUAL
C          WAY. AN ADDITIONAL OPTION EXISTS FOR PRINTING THE
C          CARTESIAN VELOCITY-COMPONENTS WHICH MAY BE
C          ACTIVATED BY SETTING THE FOLLOWING LOGICALS:
C               STOVAR(U2)=.T. FOR U-COMPONENT (CARTESIAN)
C               STOVAR(V2)=.T. FOR V-COMPONENT (CARTESIAN)
```

```
C              STOVAR(W2)=.T. FOR W-COMPONENT (CARTESIAN)
C          SIMILARLY PRINTOUT OF NON-ORTHOGONAL VELOCITY
C          COMPONENTS MAY BE ACTIVATED AS FOLLOWS:
C              STOVAR(C4)=.T. FOR U-COMPONENT (NON-ORTHOG)
C              STOVAR(H3)=.T. FOR V-COMPONENT (NON-ORTHOG)
C              STOVAR(21)=.T. FOR W-COMPONENT (NON-ORTHOG)
C       B) BFC (TO ACTIVATE THE BFC OPTION), IGEN (THE CODE FOR METHOD
C          OF GRID SPECIFICATION), ND (NUMBER OF SUB-DOMAINS) AND
C          NBFC (THE F1 ARRAY DIMENSION), MUST BE SET BEFORE
C          "STANDARD BFC SECTION 2".                    ======
C          ALL OTHER BFC DATA MUST BE SET AFTER "STANDARD BFC
C          SECTION 2.                          =====
C       C) NXP1, NYP1, NZP1 STORE NX+1, NY+1, NZ+1; THESE ARE
C          AVAILABLE TO USER AFTER STANDARD BFC SECTION 2.
C       D) FOR IGEN=1 USE BXFRAC,BYFRAC & BZFRAC IN PLACE OF
C          XFRAC,YFRAC & ZFRAC.
C-----------------------------------------------------------------
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD BFC SECTION 1 STARTS:
C     DEFAULT SETTINGS:
      NCART=10
      BFC=.TRUE.
      IGEN=1
      ND=1
      NBFC=5000
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD BFC SECTION 1 ENDS.:
C    *USER SETS BFC, IGEN, ND AND NBFC HERE:
C
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD BFC SECTION 2 STARTS:
      CALL SB4I(NXP1,NX+1,NYP1,NY+1,NZP1,NZ+1,I,0)
      IF(BFC) CALL BFCDFT(NBFC,XE,XW,YN,YS,ZH,ZL,ND,NXP1,NYP1,
     &                    NZP1,NZ)
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD BFC SECTION 2 ENDS.
C    *USER SETS ALL OTHER BFC VARIABLES HERE:
C    *USING NONIFORM GRID 1-8
      GH=6.4E-3
```

```
      GL=95.2E-3
      GTL=1.24*GL
      GBETA=4.
      GBETA=GBETA*3.1415927/180
      GTAB=TAN(GBETA)
      DELMAX=2.E-3
      GNBL=5.
      GPWR=3.
      DO 64 IY=1,5
   64 BYFRAC(IY)=(FLOAT(IY)/GNBL)**GPWR*DELMAX/(10.*GH)
      DEL=(1.-DELMAX/(10.*GH))/(FLOAT(NY)-GNBL)
      DO 65 IY=6,NY
   65 BYFRAC(IY)=BYFRAC(IY-1)+DEL
      BZFRAC(1)=42.373E-3
      DO 66 IZ=2,8
   66 BZFRAC(IZ)=42.373E-3+BZFRAC(IZ-1)
      DO 67 IZ=9,14
   67 BZFRAC(IZ)=84.75E-3+BZFRAC(IZ-1)
      DO 68 IZ=15,16
   68 BZFRAC(IZ)=42.373E-3+BZFRAC(IZ-1)
      DO 69 IZ=17,22
   69 BZFRAC(IZ)=11.295E-3+BZFRAC(IZ-1)
      CALL DOMAIN(1,1,NX,1,NY,1,NZ)
      DO 61 IX=1,NXP1
      DO 62 IY=1,NYP1
      ZL(IX,IY,1)=0.0
   62 ZH(IX,IY,1)=GTL
      DO 63 IZ=1,NZP1
      YN(IX,IZ,1)=10*GH
   63 YS(IX,IZ,1)=0.0
      DO 663 IZ=6,20
  663 YS(IX,IZ,1)=(BZFRAC(IZ-1)-BZFRAC(5))*GTAB*GTL
      DO 664 IIZ=21,22
  664 YS(IX,IIZ,1)=YS(IX,20,1)
   61 CONTINUE
```

```
      STORSA(IFIX(LOW))=.TRUE.
      STORSA(IFIX(HIGH))=.TRUE.
      STORSA(IFIX(SOUTH))=.TRUE.
      STORWD(IFIX(SOUTH))=.TRUE.
      PRTBFC=.TRUE.
CDAR  DARCY=1.E10
C------------------    --------------    ------------------
C---  GROUP 7. BLOCKAGE: BLOCK<.F.>,IPLANE,IPWRIT
C     *SET CONSTANT POROSITIES OVER SUB-DOMAINS USING:
C      CALL CONPOR(IR,TYPE,VALUE,IXF,IXL,IYF,IYL,IZF,IZL), WHERE:
C      IR=RUN SECTION NUMBER, E.G. 1 FOR RUN1 SECTION; 'TYPE'= EAST,
C      WEST, NORTH, SOUTH, HIGH, LOW & CELL. 'VALUE'=WANTED POROSITY
C      OVER REGION IXF,...IZL.
C     *DIMENSION ARRAYS PE(NX,NY,NZ), PN(NX,NY,NZ), PH(NX,NY,NZ), &
C      PC(NX,NY,NZ) ABOVE.
C     *FOR FULLY-BLOCKED CELLS (IE. 'VALUE'= 0.0) USER NEED SET ONLY
C      THE 'CELL' POROSITY (TO ZERO), AS CELL-FACE AREAS ARE THEN
C      AUTOMATICALLY ZEROED.
C     *FOR SATELLITE PRINTOUT OF ALL POROSITIES IN DOMAIN, 'IPLANE'=
C      XPLANE YPLANE OR ZPLANE, FOR DESIRED CROSS-SECTION DIRECTION.
C     *FOR EACH 'TYPE' A MAXIMUM OF 10 CALLS TO CONPOR IS ALLOWED,
C      BUT IF REQUIREMENTS EXCEED THIS PROVISION SET BLOCK=.T. &
C      IPWRIT=-1, AND SET POROSITY ARRAYS EXPLICITLY HERE AS WANTED.
C      IN THIS CASE, THE USER  M U S T   SET  A L L  ELEMENTS OF
C      ARRAYS PE, PN, PH, PC (MANY MAY BE 0.0 OR 1.0). HE MAY USE:
C      CALL CR(PARRAY,VALUE,IXF,IXL,IYF,IYL,IZF,IZL,NX,NY,NZ)
C      ANY NUMBER OF TIMES, TO SET 'PARRAY' (= PE, ETC.) TO
C      'VALUE' OVER RANGE IXF TO IXL, IYF TO IYL, IZF TO IZL.
C     *CONPOR  M U S T  N O T  BE USED IN CONJUNCTION WITH EXPLICIT
C      SETTINGS OF THE ARRAYS (INCLUDING SETTINGS VIA CR).
C------------------    --------------    ------------------
C---  GROUP 8.DEPENDENT VARIABLES TO BE SOLVED FOR OR STORED :
C      SOLVAR(1-25)<25*.F.>,STOVAR(1-25)<25*.F.>,CONC1(1-4)<4*.T.>
C      USE FOLLOWING NAMED INTEGERS FOR ARRAY ELEMENTS 1-20:
C      P1,PP,U1,U2,V1,V2,W1,W2,M1,M2,RS,KE,EP,H1,H2,H3,C1,C2,C3,C4.
```

```
      SOLVAR(P1)=.TRUE.
      SOLVAR(PP)=.TRUE.
      SOLVAR(V1)=.TRUE.
      SOLVAR(W1)=.TRUE.
      SOLVAR(H1)=.TRUE.
CT    SOLVAR(KE)=.TRUE.
CT    SOLVAR(EP)=.TRUE.
      STOVAR(V2)=.TRUE.
      STOVAR(W2)=.TRUE.
      STOVAR(C1)=.TRUE.
      STOVAR(C2)=.TRUE.
C-------------------   ---------------   ------------------
C---  GROUP 9. VARIABLE LABELS :
C     TITLE(1-25)<2HP1,2HPP,2HU1,2HU2,2HV1,2HV2,2HW1,2HW2,2HR1,
C     2HR2,2HRS,2HKE,2HEP,2HH1,2HH2,2HH3,2HC1,2HC2,
C     2HC3,2HC4,2HRX,2HRY,2HRZ, 2*4H****>
C     TITLE(C1)=4HMACH
C     TITLE(C2)='TEMP'
C     TITLE(PP)='RHO1'
C-------------------   ---------------   ------------------
C---  GROUP 10 PROPERTIES:
C     IRHO1<1>,IRHO2<1>,RHO1<1.0>,RHO2<1.0>,
C     ARHO1<1.0>,ERHO1<1.0>,CRHO1<1.0>
C     IEMU1<1>,EMU1<1.0>,EMULAM<1.E-10>
C     IHSAT,H1SAT,H2SAT,PSATEX<1.0>
C     SIGMA(1-25)<1.0,2.0,1.,1.E10,1.,1.E10,1.,1.E10,
C     4*1.0,1.314,1.0,1.E10,10*1.0>
      IRHO1=4.
      PTOT=55.E5
      TOT=555.55
      RAIR=287.
      GAMA=1.35
      CP=RAIR/(1-1/GAMA)
      TW=323.
      HWALL=TW*CP
```

```
      HTOT=CP*TOT
      RHTOT=PTOT/TOT/RAIR
      LOGIC(87)=.TRUE.
      ARHO1=RHTOT/PTOT**(1/GAMA)
      BRHO1=1./GAMA
C  TURBULENT FLOW
      IEMU1=-1
      EMU1=1.E-5
      EMULAM=EMU1
      SIGMA(24)=0.7
      SIGMA(14)=0.7
C-------------------    --------------    ------------------
C---  GROUP 11 INTER-PHASE TRANSFER PROCESSES :
C     ICFIP,CFIPS,IMDOT,CMDOT,CA1I<1.E6>,CA2I<1.E6>
C-------------------    --------------    ------------------
C---  GROUP 12 SPECIAL SOURCES :
C     ISPCSO(1-25),AGRAVX,AGRAVY,AGRAVZ,ABUOY,HREF
C-------------------    --------------    ------------------
C---  GROUP 13 INITIAL FIELDS :
C     FIINIT(1-25)<25*1.E-10>
C    MACH NO. OF FREE STREAM
      GMACH=3.2
      A=1+(GAMA-1)/2*GMACH**2
      TE=TOT/A
      RHE=RHTOT/A**(1/(GAMA-1))
      PSTAT=PTOT/A**(GAMA/(GAMA-1))
      RHO1=ARHO1*PSTAT**BRHO1
      SONIC=SQRT(GAMA*RAIR*TE)
      WIN=SONIC*GMACH
      RKEIN=0.01*WIN**2
      EPIN=0.16*RKEIN**1.5/GH
      FIINIT(W1)=WIN
      FIINIT(P1)=PSTAT
      FIINIT(H1)=HTOT
      FIINIT(KE)=RKEIN
```

```
      FIINIT(EP)=EPIN
C-------------------    ---------------    -------------------
C---  GROUP 14 BOUNDARY/INTERNAL CONDITIONS :
C     ILOOP1,ILOOPN,XCYCLE<.F >,PBAR,REGION(1-10)<10*.T.>
C    *N.B. ALL 10 REGIONS ARE DEFAULTED TRUE..  THE USER SHOULD
C     SET REGION(I)=.FALSE. FOR UNUSED REGIONS 'I'.
      DO 14 I=1,10
   14 REGION(I)=.FALSE.
C-------------------    ---------------    -------------------
C---  GROUP 15 TO 24; REGIONS 1 TO 10
C---  ONLY THOSE REGIONS ARE ACTIVE WHICH ARE SPECIFIED BY THE
C     USER, PREFERABLY BY WAY OF:-
C     CALL PLACE(IREGN,TYPE,IXF,IXL,IYF,IYL,IZF,IZL) &
C     CALL COVAL(IREGN,VARBLE,COEFF,VALUE)
      CALL PLACE(1,LOW,1,NX,1,NY,1,1)
C     CALL COVAL(1,M1,FIXFLU,WIN*RHE)
CDAR  CALL COVAL(1,M1,1.E-20,1.E+20*WIN*RHE)
      GCM=2*GAMA/WIN/(GAMA-1)
      GVM=PTOT*RHE/RHTOT
      CALL COVAL(1,M1,GCM,GVM)
      CALL COVAL(1,W1,ONLYMS,WIN)
      CALL COVAL(1,H1,ONLYMS,HTOT)
C     CALL COVAL(1,KE,ONLYMS,RKEIN)
C     CALL COVAL(1,EP,ONLYMS,EPIN)
      CALL PLACE(2,HIGH,1,NX,1,NY,NZ,NZ)
C     CALL COVAL(2,M1,FIXVAL,PSTAT*0.)
      CALL COVAL(2,M1,1000*WIN*RHE/PSTAT,PSTAT)
C   WALL ALONG THE VANE  IZ(6,22)
      GCM=EMU1/(.5*BYFRAC(1)*10.*GH)
      DY1=BYFRAC(1)*10.*GH
      COEFF=EMU1/(0.5*DY1)
      GOEFH=EMU1/(0.5*DY1*SIGMA(24))
      CALL PLACE(3,SOUTH,1,NX,1,1,6,22)
      CALL COVAL(3,W1,GOEFF,0.)
      CALL COVAL(3,H1,GOEFH,HWALL)
```

```
C     CALL COVAL(3,KE,WALL,0.)
C     CALL COVAL(3,EP,WALL,0.)
C------------------    --------------    ------------------
C---  GROUP 25 GROUND STATION :
C     GROSTA<.F.>,NAMLST<.F.>
C    *NAMLST ACTIVATES NAMELIST IN GROUND.
      GROSTA=.TRUE.
C------------------    --------------    ------------------
C---  GROUP 26 SOLUTION TYPE AND RELATED PARAMETERS :
C     WHOLEP<.F.>,SUBFST<.F.>,DONACC<.F.>
      WHOLEP=.TRUE.
C------------------    --------------    ------------------
C---  GROUP 27 SWEEP AND ITERATION NUMBERS :
C     FSWEEP<1>,LSWEEP<1>,LITHYD<1>,LITC<1>,LITKE<1>,LITH<1>,
C     LITER(1-25)<9*1,-1,15*1>
C     IVELF<1>,NVEL<1>,IVELL<10000>,
C     IKEF<1>,NKE<1>,IKEL<10000>,
C     IENTF<1>,NENT<1>,IENTL<10000>,
C     ICNCF<1>,NCNC<1>,ICNCL<10000>,
C     IRHO1F<1>,NRHO1<1>,IRHO1L<10000>,
C     IRHO2F<1>,NRHO2<1>,IRHO2L<10000>
      LSWEEP=100
      GSWP=LSWEEP
CR    FSWEEP=200
      LITER(PP)=20
      LITER(V1)=2
      LITER(W1)=5
C     LITHYD=2
C------------------    --------------    ------------------
C---  GROUP 28 TERMINATION CRITERIA :
C     ENDIT(1-25)<9*1.E-10,0.5,15*1.E-10>
      ENDIT(1)=1.E-5
C------------------    --------------    ------------------
C---  GROUP 29 RELAXATION  :
C     RLXP<1.>,RLXPXY<1.>,RLXPZ<1.>,RLXRHO<1.>,RLXNDT<1.>,
```

```
C     DTFALS(3-25)<23*1.E10>
      DTFALS(W1)=1.E-5
      DTFALS(V1)=1.E-4
      RLXP=.2
C------------------    --------------    ------------------
C---  GROUP 30 LIMITS :
C     VELMAX<1.E10>,VELMIN<-1.E10>,RHOMAX<1.E10>,RHOMIN<1.E-10>,
C     TKEMAX<1.E10>,TKEMIN<1.E-10>,EMUMAX<1.E10>,EMUMIN<1.E-10>,
C     EPSMAX<1.E10>,EPSMIN<1.E-10>,AMDTMX<1.E10>,AMDTMN<-1.E10>
C------------------    --------------    ------------------
C---  GROUP 31 SLOWING DEVICES : SLORHO<1.>,SLOEMU<1.>
      SLORHO=.5
C------------------    --------------    ------------------
C---  GROUP 32 PRINT-OUT OF VARIABLES :
C     PRINT(1-25)<.T.,.F.,23*.T.>,SUBWGR<.F.>
      PRINT(C1)=.TRUE.
      PRINT(C2)=.TRUE.
      PRINT(PP)=.TRUE.
C------------------    --------------    ------------------
C---  GROUP 33 MONITOR PRINT-OUT :
C     IXMON<1>,IYMON<1>,IZMON<1>,NPRMON<1>,NPRMNT<1>
      NPRMON=5
      IYMON=2
      IZMON=5
C------------------    --------------    ------------------
C---  GROUP 34 FIELD PRINT-OUT CONTROL :
C     NPRINT<100>,NTPRIN<100>,NXPRIN<1>,NYPRIN<1>,NZPRIN<1>,
C     IZPRF<1>,ISTPRF<1>,IZPRL<10000>,ISTPRL<10000>
C     NUMCLS<10>,KOUTPT
      NPRINT=LSWEEP
      NUMCLS=5
C------------------    --------------    ------------------
C---  GROUP 35 TABLE CONTROL :
C     TABLES<.F.>,NTABLE,NTABVR,LINTAB,NPRTAB,NMON,
C     ITAB(1-8),MTABVR(1-8)
```

```
C------------------    --------------    ------------------
C     GROUP 36-38 ARE NOT DOCUMENTED IN THE INSTRUCTION
C     MANUAL AND ARE INTENDED FOR MAINTENANCE PURPOSES ONLY
C---  GROUP 36 DEBUG PRINT-OUT SLAB AND TIME-STEP :
C     IZPR1<1>,IZPR2<1>,ISTPR1<1>,ISTPR2<1>
C------------------    --------------    ------------------
C---  GROUP 37 DEBUG SWEEP AND SUBROUTINES :
C     KEMU,KMAIN,KINDEX,KGEOM,KINPUT,KSODAT,KCOMPF,KSORCE,
C     KSOLV1,KSOLV2,KSOLV3,KCOMPP,KADJST,KFLUX,KSHIFT,KDIF,
C     KCOMPU,KCOMPV,KCOMPW,KCOMPR,KWALL,KDBRHO<-1>,KDBEXP,KDBMDT
C     KDBGEN
C------------------    --------------    ------------------
C---  GROUP 38 MONITOR,TEST,AND FLAG :
C     MONITR<.F.>,FLAG<.F.>,TEST<.T.>,KFLAG<1>
C     END OF MAINTENANCE-ONLY SECTION
C------------------    --------------    ------------------
C---  GROUP 39 ERROR AND RESIDUAL PRINT-OUT :
C     IERRP<1000>,RESREF(1,3-24)<25*1.>,RESMAP<.F.>,
C     RESID(1-25)<2*.F.,23*.T.>,KOUTPT
      RESREF(1)=WIN*RHE
      RESREF(7)=WIN*RESREF(1)
      RESREF(5)=WIN*RESREF(1)*0.1
      RESREF(H1)=HTOT*RESREF(1)
      RESREF(KE)=RKEIN*RESREF(1)
      RESREF(EP)=EPIN*RESREF(1)
      IERRP=LSWEEP/10
      KOUTPT=LSWEEP/10
C------------------    --------------    ------------------
C---  GROUP 40 SPECIAL DATA : LOGIC(1..10),INTGR(1..10),RE(21..30),
C     NLSP<1>,NISP<1>,NRSP<1>,SPDATA<.F.>,LSPDA(1),ISPDA(1),RSPDA(1)
C     USE FIRST 10 ELEMENTS OF ARRAYS LOGIC & INTGR AND 21ST
C     TO 30TH OF ARRAY RE FOR TRANSFERRING SPECIAL DATA FROM
C     SATELLITE TO GROUND, BUT IF REQUIREMENTS EXCEED THIS
C     PROVISION SET SPDATA = .T., AND DIMENSION ARRAYS LSPDA,
C     ISPDA, RSPDA ABOVE AND IN GROUND AS NEEDED, AND SET HERE
```

```
C-------------------------------------------------------------
C---  GROUP 42 RESTARTS AND DUMPS : SAVEM<.F.>,RESTRT<.F.>,KINPUT
      SAVEM=.TRUE.
      BFPLOT=.TRUE.
C     RESTRT=.TRUE.
C-------------------    --------------    ------------------
C-------------------    --------------    ------------------
C---  GROUP 43 GRAFFIC :
C     GRAPHS<.F.>,ORTHOG<.T.>,ANTSYM,NPRT<1>,ITITL<5*4H****>
C---  FOR A GRAFFIC RUN, DIMENSION PHI1 & PHI2 AS FOLLOWS:
C     PHI1(NX*NY*NZ*NM)
C     PHI2((NX+2)*(NY+2)*(NZ+2)*(NM+IBLK)) , WHERE
C     NM=NO. OF VARIABLES STORED + DENSITY(-IES)
C     IBLK=0 IF BLOCK=.FALSE.,=4 IF A 3D RUN,
C     =3 IF A 2D.YZ RUN.
C-------------------    --------------    ------------------
          IF(IRUN.EQ.1) GO TO 900
  900 CONTINUE
C---  ALL RUNS
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 3 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 4 STARTS:
C-------------------------------------------------------------
C  WRITE GENERAL DATA ON TO THE GUSIE1.DTA TAPE, ETC...
          IF(SPDATA) CALL WRTSPC(LSPDA,NLSP,ISPDA,NISP,RSPDA,NRSP)
          IF(BLOCK) CALL WRTPOR(PE,PN,PH,PC,NX,NY,NZ,IPLANE)
       IF(BFC) CALL WRTBFC(14,NBFC,XE,XW,YN,YS,ZH,ZL,
     &ND,NX+1,NY+1,NZ+1,NZ,PRTBFC)
C     OLD PRACTICES RETAINED FOR REFERENCE:
C          IF(SPDATA) CALL SPCDAT(IRUN)
C          IF(BLOCK) CALL PORDAT(IRUN)
           IF(GRAPHS) CALL SORT(IRUN)
           IF(RESTRT) GO TO 902
         DO 901 INDVAR=1,25
           IF(IFIX(FIINIT(INDVAR)+0.1).NE.10101) GO TO 901
       CALL FLDDAT(IRUN)
```

```
      GO TO 902
  901 CONTINUE
  902 CALL DATAIO(WRT,10)
          IF(MONITR) CALL DATAIO(WRT,-6)
  999 CONTINUE
      STOP
      END
C***   IGEN=1 SO BFCXYZ NOT REQUIRED.
C***   COMMENT OUT BOTH VERSIONS.
C-------------------------------------------------------------
      SUBROUTINE BFCXYZ (NXP1,NYP1,NZP1)
      RETURN
      END
```

APPENDIX B

GROUND PROGRAM OF PHOENICS FOR LAMINAR FLOW ANALYSIS

```
C$DIRECTIVE**MAIN
C     GROUND PROGRAM OF PHOENICS USED IN LAMINAR FLOW ANALYSIS
C     NZ=22 NY=25 LAMINAR FLOW
C     *FILE NAME: MODBFCGD.FTN
C     *INCLUDE DED SUBROUTINES: THE MODELS OF MAIN, GROUND & STRIDE.
C     *DOCUMENTATION: PHOENICS INSTRUCTION MANUAL (SPRING 1983)
C      WITH BODY-FITTED COORDINATES INSTRUCTION SUPPLEMENT
C      (SUMMER 1984).
C     *SATELLITE FILE NAME: MODSTL.FTN
       COMMON/ISHIFT/III(57),NFMAX
C SET F-ARRAY DIMENSION AS NEEDED, & SET NFMAX ACCORDINGLY.
C      FOR BFC'S ALSO SET F1-ARRAY DIMENSION AS NEEDED ,AND SET
C      NF1MAX ACCORDINGLY.
       COMMON/FOB/F1(10000)
       COMMON/NFOB/NF1MAX
       COMMON F(25000)
       NFMAX=25000
       NF1MAX=10000
       CALL MAIN1
       STOP
       END
C$DIRECTIVE**GROUND
       SUBROUTINE GROUND(IRN,ICHAP,ISTP,ISWP,IZED,INDVAR)
       INCLUDE (CMNGUS)
       INCLUDE (GUSSEQ)
C       INCLUDE NMLIST
       LOGICAL BFC
       EQUIVALENCE (LOGIC(20),BFC)
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 1 STARTS:
C-------------------------------------------------------------------
```

```
C+++++MEANING OF SUBROUTINE ARGUMENTS:
C     IRN=RUN NUMBER; ICHAP=CHAPTER CALLED; ISTP=TIME STEP;
C     ISWP=SOLUTION SWEEP; IZF)=Z-SLAB; INDVAR: SEE CHAPTERS BELOW.
C+++++USER-INTRODUCED VARIABLES & ARRAYS:
C     TO AVOID CONFLICT WITH VARIABLE NAMES USED IN COMMON, ALL
C     VARIABLES INTRODUCED BY THE USER SHOULD HAVE NAMES STARTING
C     WITH 'G' IF REAL, 'J' IF INTEGER, AND 'G' OR 'J' IF LOGICAL.
C     THUS GDZ(IZ) MIGHT BE A Z-INTERVAL ARRAY;
C     GW1(IY,IX) A 2-D ARRAY FOR AXIAL VELOCITY; ETC.
C     USER-GENERATED SUBROUTINES SHOULD BE NAMED CORRESPONDINGLY,EG
C     SUBROUTINE GVISC(GTEMP,GCNC,GVSC), FOR COMPUTING VISCOSITY
C     FROM CONCENTRATION & TEMPERATURE.
C+++++GROUND-TO-EARTH CONNECTING SUBROUTINES:
C    *USE GET(NAME,GARRAY,NY,NX) TO PUT VALUES OF VARIABLE NAMED
C     'NAME' INTO ARRAY 'GARRAY' DIMENSIONED GARRAY(NY,NX).
C    *USE SET(NAME,IXF,IXL,IYF,IYL,GARRAY,NY,NX) TO SET VARIABLE
C     'NAME' TO GARRAY(IY,IX) OVER THE REGION: IXF-IXL & IYF-IYL.
C    *USE PRNSLB(NAME) TO PRINT VARIABLE 'NAME' OVER X-Y PLANE.
C    *USE ADD(NAME,IXF,IXL,IYF,IYL,TYPE,CM,VM,CVAR,VVAR,NY,NX)
C     TO ADD SOURCE TO VARIABLE NAMED 'NAME' (SEE CHAPTER 5).
C    *USE READIZ(IZED) IN CHAPTERS 1, 2, 8, & 9 TO ACCESS P1,...DM
C     & VOL,...AHDZ. (SEE FOOTNOTE TO LEGALITY TABLE)
C    *USE GET1D(NAME,GARRAY,NDIM) TO PUT VARIABLE NAMED 'NAME' IN
C     ONE-D ARRAY 'GARRAY' DIMENSIONED NDIM, THUS:
C     CALL GET1D(NAME,GNX,NX) FOR XG,...DXG & DIMENSION GNX(NX);
C     CALL GET1D(NAME,GNY,NY) FOR YG,...RV & DIMENSION GNY(NY);
C     CALL GET1D(NAME,GNZ,NZ) FOR ZG,...WGRID & DIMENSION GNZ(NZ).
C+++++LEGALITY TABLE FOR USE OF EARTH-CONNECTING SUBROUTINES:
C     ENTRIES IN TABLE GIVE CHAPTERS IN WHICH SUBROUTINES CAN BE
C     USED FOR VARIABLES IN LEFT-HAND COLUMN. (SUBROUTINE
C     STRIDE IS REGARDED AS BEING IN CHAPTER 3)
C     ------------------------------------------------------
C     : VARIABLE:: GET & : SET : ADD : READIZ : GET1D :
C     :          ::  PRNSLB :     :     :       :       :
C     ------------------------------------------------------
```

```
C     :P1 - RZ  ::     ALL    :  6 & 7 :    5     : 1,2,8,9:  NONE  :
C     :P10 - RZH::3-7, 10-16:     3    :  NONE   :  NONE   :  NONE  :
C     :VOL -AHDZ::     ALL    :     3    :  NONE   : 1,2,8,9:  NONE  :
C     :D1DP     ::     NONE   :    10    :  NONE   :  NONE   :  NONE  :
C     :D2DP     ::     NONE   :    11    :  NONE   :  NONE   :  NONE  :
C     :MU1,MU1H ::  5,13-16   :    12    :  NONE   :  NONE   :  NONE  :
C     :EXCO(L,H)::     NONE   :    13    :  NONE   :  NONE   :  NONE  :
C     :CFP      ::      5     :    14    :  NONE   :  NONE   :  NONE  :
C     :MDT      ::      5     :    15    :  NONE   :  NONE   :  NONE  :
C     :HST1,HST2::   5 & 15   :    16    :  NONE   :  NONE   :  NONE  :
C     :XG -WGRID::     NONE   :  NONE    :  NONE   :  NONE   :  ALL   :
C     ------------------------------------------------------------------
C     NOTES ON ABOVE TABLE:
C    *IN CHAPTERS 1, 2, 8, & 9 VARIABLES P1...DM & GEOMETRY
C     VOL...AHDZ CAN BE ACCESSED BUT ONLY IN CONJUNCTION WITH
C     USE OF READIZ, THUS:
C     DO 1 IZED=1,NZ
C     CALL READIZ(IZED)
C    1 CALL GET(... AS REQUIRED..)
C    *GEOMETRY ACCESSED BY READIZ IS THAT AT INITIAL TIME.
C    *D1DP & D2DP ONLY ACCESSIBLE IN UNSTEADY FLOWS.
C+++++GROUND SERVICE SUBROUTINES:
C    *USE CONTUR(NAME,IPLANE,ILOC,NINT,I1,I2,J1,J2,GARRAY,NDIM) FOR
C     LINE-PRINTER PLOTS OF CONTOURS. 'NAME' = U1,...C4;
C     'IPLANE'= XPLANE, YPLANE, OR ZPLANE; ILOC SETS IX, IY, OR
C     IZ LOCATION OF IPLANE; I1, I2, J1, & J2 SET FIRST & LAST
C     CELLS IN HORIZ. & VERT. ON PLOT; GARRAY IS 1-D WORKING ARRAY
C     OF DIMENSION NX*NY, NX*NZ, OR NY*NZ DICTATED BY IPLANE; &
C     NDIM SETS VALUE OF DIMENSION OF GARRAY.
C    *USE FLD2DA(TITLE,GARRAY,NY,NX) TO PRINT ANY ARRAY DIMENSIONED
C     GARRAY(NY,NX); SET 'TITLE' TO REQUIRED NAME ( 4 HOLLERITH
C     CHARACTERS ONLY).
C    *USE FLD3DA(TITLE,GARRAY,NX,NY,NZ,IPLANE,ILOC) TO PRINT ANY
C     ARRAY DIMENSIONED GARRAY(NX,NY,NZ) IN PLANE SPECIFIED BY
C     'IPLANE' & 'ILOC' AS FOR CONTUR ABOVE; SET 'TITLE' AS FOR
```

```
C     FLD2DA.
C     VARIABLE NAMES FOR USE IN GROUND:
      COMMON/TYPE/CELL,EAST,WEST,NORTH,SOUTH,HIGH,LOW,VOLUME,WALL
      COMMON/VAR/P1,PP,U1,U2,V1,V2,W1,W2,R1,R2,RS,
     4.12,EP,H1,H2,H3,C1,C2,C3,C4,RX,RY,RZ,S1,S2
      COMMON/VAROLD/P10,PP0,U10,U20,V10,V20,W10,W20,R10,R20,RS0,
     &KE0,EP0,H10,H20,H30,C10,C20,C30,C40,RX0,RY0,RZ0,S10,S20
      COMMON/VARLOW/P1L,PPL,U1L,U2L,V1L,V2L,W1L,W2L,R1L,R2L,RSL,
     &KEL,EPL,H1L,H2L,H3L,C1L,C2L,C3L,C4L,RXL,RYL,RZL,S1L,S2L
      COMMON/VARHI/P1H,PPH,U1H,U2H,V1H,V2H,W1H,W2H,R1H,R2H,RSH,
     &KEH,EPH,H1H,H2H,H3H,C1H,C2H,C3H,C4H,RXH,RYH,RZH,S1H,S2H
      COMMON/GMTRY/VOL,VOLO,AEAST,ANORTH,AHIGH,AEDX,ANDY,AHDZ
      COMMON/PROP/D1,D2,D1DP,D2DP,MU1,MU1LAM,EXCO,CFP,MDT,HST1,HST2
      COMMON/PRPOLD/D10,D20
      COMMON/PRPLOW/D1L,D2L,EXCOL
      COMMON/PRPHI/D1H,D2H,MU1H,EXCOH
      COMMON/VARNX/XG,XU,DXU,DXG
      COMMON/VARNY/YG,YV,DYV,DYG,R,RV
      COMMON/VARNZ/ZG,ZW1,DZW,DZG,WGRID
      COMMON/GDMSCI/XPLANE,YPLANE,ZPLANE,ITNO
      COMMON/GDMSCL/LSLAB,MSLAB,NSLAB,LAMMU
      REAL NORTH,LOW
      INTEGER    P1,PP,U1,U2,V1,V2,W1,W2,R1,R2,RS,
     &EP,H1,H2,H3,C1,C2,C3,C4,RX,RY,RZ,S1,S2
      INTEGER    P10,PP0,U10,U20,V10,V20,W10,W20,R10,R20,RS0,
     &EP0,H10,H20,H30,C10,C20,C30,C40,RX0,RY0,RZ0,S10,S20
      INTEGER    P1L,PPL,U1L,U2L,V1L,V2L,W1L,W2L,R1L,R2L,RSL,
     &EPL,H1L,H2L,H3L,C1L,C2L,C3L,C4L,RXL,RYL,RZL,S1L,S2L
      INTEGER    P1H,PPH,U1H,U2H,V1H,V2H,W1H,W2H,R1H,R2H,RSH,
     &EPH,H1H,H2H,H3H,C1H,C2H,C3H,C4H,RXH,RYH,RZH,S1H,S2H
      INTEGER VOL,VOLO,AEAST,ANORTH,AHIGH,AEDX,ANDY,AHDZ
      INTEGER D1,D1DP,D2,D2DP,EXCO,CFP,HST1,HST2
      INTEGER D10,D20,D1L,D2L,EXCOL,D1H,D2H,EXCOH
      INTEGER XG,XU,DXU,DXG,YG,YV,DYV,DYG,R,RV,ZG,ZW1,DZW,
     &DZG,WGRID
```

```
      INTEGER XPLANE,YPLANE,ZPLANE
      LOGICAL LSLAB,MSLAB,HSLAB,LAMMU,LSPDA
      EQUIVALENCE (M1,R1),(M2,R2)
C     SATLIT-EQUIVALENT IRUN:
      EQUIVALENCE (IRUN,INTGR(11))
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 1 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 1 STARTS:
C     ARRAYS ( DIMENSIONED NY,NX ) FOR USE WITH 'ADD':
      DIMENSION CVAR(1,1),VVAR(1,1),CM(1,1),VM(1,1),ZERO(1,1)
      DIMENSION GP(30,1),GH(30,1),GD(30,1),GV(30,1),GW(30,1)
     1 ,GMACH(30,1),GTEMP(30,1),GVISC(30,1)
C     SPECIAL-DATA ARRAYS DIMENSIONED & DIMENSION VALUES SET HERE:
      DIMENSION LSPDA(1),ISPDA(1),RSPDA(1)
C     USER PLACES HIS VARIABLES, ARRAYS, EQUIVALENCES ETC. HERE.
      EQUIVALENCE (RAIR,RE(21)),(GAMA,RE(22)),(GSWP,RE(23))
      DATA NLSP,NISP,NRSP/1,1,1/
      DATA CVAR,VVAR,CM,VM,ZERO/5*0.0/
C     USER PLACES HIS DATA STATEMENTS HERE.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 1 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 2 STARTS:
C     PLEASE DO NOT ALTER, OR RE-SET, ANY OF THE REMAINING
C     STATEMENTS OF THIS SECTION.
      DATA NUMCH4 / 0 /
          IF(SPDATA)
     &CALL RDSPC(IRN,INTGR(12),LSPDA,NLSP,ISPDA,NISP,RSPDA,NRSP)
      CALL GRDUTY(IRN,ICHAP,IZED,INDVAR)
      IF(BFC) CALL BFCGRD(IRN,ICHAP,ISWP,IZED,INDVAR)
          IF(ICHAP.EQ.-5) GO TO 10
          IF(ICHAP.LE.0.OR.ICHAP.GT.16) RETURN
      GO TO (100,200,300,4999,500,600,700,800,900,1000,1100,1200,
     &1300,1400,1500,1600),ICHAP
      RETURN
 4999 NUMCH4= NUMCH4 + 1
      IF (MOD(NUMCH4,2).EQ.1) GO TO 400
      RETURN
```

```
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 2 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 2 STARTS:
C-----------------------------------------------------------------
C     CHAPTER 0: MODIFY SATLIT DATA, AT START OF EACH IRN.
C-----------------------------------------------------------------
   10 CONTINUE
C         IF(.NOT.NAMLST) RETURN
C         IF(IRN.EQ.NRUN) DATFIL=.FALSE.
C---  READ SATLIT DATA NAMELIST HERE
C     CALL WRIT40(40HENTER NAMELIST DATA FOR GROUPS 1 TO 24  )
C     READ(20,G1G24)
C     CALL WRIT40(40HENTER NAMELIST DATA FOR GROUPS 25 TO 42 )
C     READ(20,G25G42)
      RETURN
C-----------------------------------------------------------------
C     CHAPTER 1: CALLED AT THE START OF EACH TIME STEP.
C     SET 'DT' HERE WHEN TLAST SET NEGATIVE IN BLOCK DATA.
C     'ATIME + DT' GIVES THE END TIME OF THE CURRENT TIME STEP.
C     NOT ACCESSED IF STEADY,OR PARABOLIC.
C-----------------------------------------------------------------
  100 CONTINUE
      RETURN
C-----------------------------------------------------------------
C     CHAPTER 2: CALLED AT THE START OF EACH SWEEP.
C-----------------------------------------------------------------
  200 CONTINUE
      RETURN
C-----------------------------------------------------------------
C     CHAPTER 3: CALLED AT THE START OF EACH SLAB;
C     NOT ACCESSED IF PARABOLIC, BUT 'STRIDE' IS.
C-----------------------------------------------------------------
  300 CONTINUE
      RETURN
C-----------------------------------------------------------------
C     CHAPTER 4: CALLED AT THE START OF EACH RE-CALCULATION OF
```

```
C     VARIABLES P1,...C4 AT CURRENT SLAB. ITNO= ITERATION NUMBER.
C-----------------------------------------------------------------
  400 CONTINUE
      RETURN
C-----------------------------------------------------------------
C     CHAPTER 5: GROUND CALLED WHEN SOURCE TERM IS COMPUTED.
C     INDVAR GIVES DEPENDENT VARIABLE IN QUESTION IE. U1,...C4.
C     TO ADD SOURCE TO DEPENDENT VARIABLE C1(SAY) FOR IX=IXF,IXL
C     AND IY=IYF,IYL INSERT STATEMENT:
C     IF(INDVAR.EQ.C1)
C    &CALL ADD(INDVAR,IXF,IXL,IYF,IYL,TYPE,CM,VM,CVAR,VVAR,NY,NX)
C     NOTES ON 'ADD':
C    *SOURCE= (CVAR(IY,IX)+AMAX1(0.0,MASFLO))*(VVAR(IY,IX)-PHI),
C     WHERE 'PHI' IS IN-CELL VALUE OF VARIABLE IN QUESTION.
C    *'MASFLO'= CM(IY,IX)*(VM(IY,IX)-P),
C     WHERE 'P' IS THE IN-CELL PRESSURE.
C    *FOR INDVAR= M1, OR =M2, SOURCE ADDED IS 'MASFLO' ONLY,
C     EXCEPT FOR ONEPHS=.F. & MASFLO < 0.0 (IE. OUTFLOW) WHEN
C     CM(IY,IX) IS MULTIPLIED BY R1*D1 (FOR M1) & R2*D2 (FOR M2).
C    *BOTH 'CVAR' & 'CM' ARE MUTLIPLIED BY CELL-GEOMETRY QUANTITY
C     DICTATED BY SETTING OF 'TYPE' (=CELL, EAST AREA,..VOLUME).
C    *TYPE-SPECIFIED AREAS ARE CALCULATED AS IF BLOCKAGE ABSENT,
C     BUT 'VOLUME' WITH ACCOUNT FOR ITS PRESENCE.
C    *FOR ALL SOLVED VARIABLES, INCLUDE DING M1 ( & M2 WHEN ONEPHS=F),
C     IF 'CM'> 0.0 CALL 'ADD'; FOR M1 & M2 ALTHOUGH 'CVAR' & 'VVAR'
C     HAVE NO SIGNIFICANCE THEY MUST BE ENTERED AS ARGUMENTS.
C    *'CVAR', 'VVAR', 'CM' & 'VM' MUST BE DIMENSIONED NY,NX.
C-----------------------------------------------------------------
  500 CONTINUE
      RETURN
C-----------------------------------------------------------------
C     CHAPTER 6: CALLED AT THE END OF EACH VARIABLE-RECALCULATION
C     CYCLE COMMENCED AT CHAPTER 4. ITNO = ITERATION NUMBER.
C-----------------------------------------------------------------
  600 CONTINUE
```

```
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 7: CALLED AT END OF EACH SLAB-WISE CALCULATION.
C-----------------------------------------------------------------------
  700 CONTINUE
      IF(FLOAT(ISWP).LT.GSWP) RETURN
      CALL GET(P1,GP,NY,NX)
      CALL GET(H1,GH,NY,NX)
      CALL GET(D1,GD,NY,NX)
      CALL GET(V1,GV,NY,NX)
      CALL GET(W1,GW,NY,NX)
      GCP=RAIR/(1.-1/GAMA)
      DO 701 I=1,NY
      GSON=SQRT(GAMA*GP(I,1)/GD(I,1))
      GAV=SQRT(GV(I,1)**2+GW(I,1)**2)
      GMACH(I,1)=GAV/GSON
C 701 GTEMP(I,1)=GP(I,1)/GD(I,1)/RAIR
  701 GTEMP(I,1)=(GH(I,1)-GW(I,1)**2/2.-GV(I,1)**2/2.)/GCP
      CALL SET(C1,1,NX,1,NY,GMACH,NY,NX)
      CALL SET(C2,1,NX,1,NY,GTEMP,NY,NX)
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 8: CALLED AT THE END OF EACH SWEEP;
C     NOT ACCESSED IF PARABOLIC.
C-----------------------------------------------------------------------
  800 CONTINUE
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 9: CALLED AT THE END OF EACH TIME STEP;
C     NOT ACCESSED IF PARABOLIC.
C-----------------------------------------------------------------------
  900 CONTINUE
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 10: SET PHASE 1 DENSITY HERE WHEN IRHO1=-1 IN DATA.
```

```
C     SET CURRENT-Z 'SLAB' DENSITY, D1, IF MSLAB=.T.,
C     EG.  IF(MSLAB) CALL SET(D1,1,NX,1,NY,GD1,NY,NX).
C     SET NEXT LARGER-Z 'SLAB' DENSITY, D1H, IF MSLAB=.T. & PARAB=F
C     EG.  IF(HSLAB) CALL SET(D1H,1,NX,1,NY,GD1H,NY,NX).
C     SET D(LN(D1))/DP (IE. D1DP) FOR UNSTEADY FLOW,
C     EG.  IF(MSLAB) CALL SET(D1DP,1,NX,1,NY,GD1DP,NY,NX).
C-----------------------------------------------------------------------
 1000 CONTINUE
      IF (MSLAB) GO TO 101
      JP1=P1
      JH1=H1H
      JD1=D1H
      JW1=W1H
      JV1=V1H
      GO TO 102
  101 JP1=P1
      JH1=H1
      JD1=D1
      JW1=W1
      JV1=V1
  102 CALL GET(JP1,GP,NY,NX)
      CALL GET(JH1,GH,NY,NX)
      CALL GET(JW1,GW,NY,NX)
      CALL GET(JV1,GV,NY,NX)
      DO 103 IX=1,NX
      DO 103 IY=1,NY
      GHS=GH(IY,IX)-(GW(IY,IX)**2+GV(IY,IX)**2)/2.
  103 GD(IY,IX)= GP(IY,IX)/(1-1/GAMA)/GHS
      CALL SET(JD1,1,NX,1,NY,GD,NY,NX)
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 11: SET PHASE 2 DENSITY HERE WHEN IRHO2=-1 IN DATA.
C     SET CURRENT-Z 'SLAB' DENSITY, D2, IF MSLAB=.T.,
C     EG.  IF(MSLAB) CALL SET(D2,1,NX,1,NY,GD2,NY,NX).
C     SET NEXT LARGER-Z 'SLAB' DENSITY, D2H, IF HSLAB=.T. & PARAB=F
```

```
C     EG.  IF(HSLAB) CALL SET(D2H,1,NX,1,NY,GD2H,NY,NX).
C     SET D(LN(D2))/DP FOR UNSTEADY FLOW,
C     EG.  IF(MSLAB) CALL SET(D2DP,1,NX,1,NY,GD2DP,NY,NX).
C-----------------------------------------------------------------------
 1100 CONTINUE
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 12: SET PHASE 1 VISCOSITY HERE WHEN IEMU1=-1 IN DATA.
C     SET CURRENT-Z 'SLAB' VISCOSITY (MU1), IF MSLAB=.T.,
C     EG.  IF(MSLAB) CALL SET(MU1,1,NX,1,NY,GVISC,NY,NX).
C     SET NEXT LARGER-Z 'SLAB' VISC. (MU1H), IF HSLAB=.T. & PARAB=F
C     EG.  IF(HSLAB) CALL SET(MU1H,1,NX,1,NY,GVSCH,NY,NX).
C
C     CHAPTER ALSO ACCESSED WHEN EMULAM=-1.0 IN DATA, SO THAT THE
C     LAMINAR VISCOSITY WHICH APPEARS IN WALL FUNCTIONS & IN THE
C     KE-EP TURBULENCE MODEL (IEMU1=2) MAY BE SET NON-CONSTANT.
C     SET CURRENT-Z 'SLAB' VALUE (MU1LAM) WHEN LAMMU=.T.,
C     EG.  IF(LAMMU) CALL SET(MU1LAM,1,NX,1,NY,GVSCL,NY,NX).
C-----------------------------------------------------------------------
 1200 CONTINUE
      GCP=RAIR/(1.-1/GAMA)
      IF (MSLAB) CALL GET(H1,GH,NY,NX)
      IF (HSLAB) CALL GET(H1H,GH,NY,NX)
      IF (MSLAB) CALL GET(W1,GW,NY,NX)
      IF (HSLAB) CALL GET(W1H,GW,NY,NX)
      IF (MSLAB) CALL GET(V1,GV,NY,NX)
      IF (HSLAB) CALL GET(V1H,GV,NY,NX)
      DO 121 IX=1,NX
      DO 121 IY=1,NY
      GTMP=(GH(IY,IX)-GW(IY,IX)**2/2.-GV(IY,IX)**2/2.)/GCP
      IF(GTMP.LT.150.)  GTMP=150.
  121 GVISC(IY,IX)=1.716E-05*(GTMP/273.)**0.666
C121  IF(GVISC(IY,IX).LE..8E-5)  GVISC(IY,IX)=.8E-5
      IF (MSLAB) CALL SET(MU1,1,NX,1,NY,GVISC,NY,NX)
      IF (HSLAB) CALL SET(MU1H,1,NX,1,NY,GVISC,NY,NX)
```

```
      IF (LAMMU) CALL SET(MU1LAM,1,NX,1,NY,GVISC,NY,NX)
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 13: SET EXCHANGE COEFFICIENT (E.C.) FOR VARIABLE
C     INDVAR WHEN SIGMA(INDVAR)=-1.0 IN DATA.
C     SET CURRENT-Z 'SLAB' E.C. (EXCO) IF MSLAB=.T.,
C     EG.  IF(MSLAB) CALL SET(EXCO,1,NX,1,NY,GEXCO,NY,NX).
C     SET NEXT SMALLER-Z 'SLAB' E.C. (EXCOL) IF LSLAB=.T.,
C     EG.  IF(LSLAB) CALL SET(EXCOL,1,NX,1,NY,GEXCOL,NY,NX).
C     SET NEXT LARGER-Z  'SLAB' E.C. (EXCOH) IF HSLAB=.T.,
C     EG.  IF(HSLAB) CALL SET(EXCOH,1,NX,1,NY,GEXCOH,NY,NX).
C     NOTE: FOR MSLAB, INDVAR=U1,..C4; FOR LSLAB, INDVAR=U1L,..C4L
C     & FOR HSLAB, INDVAR=U1H,..C4H. IF PARAB=.T. SET MSLAB ONLY.
C-----------------------------------------------------------------------
 1300 CONTINUE
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 14: SET INTER-PHASE FRICTION COEFFICIENT (CFP) HERE
C     WHEN ICFIP = -1 IN DATA; ITS UNITS = FORCE / (CELL * RELATIVE
C     SPEED OF PHASES).
C-----------------------------------------------------------------------
 1400 CONTINUE
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 15: SET INTER-PHASE MASS-TRANSFER RATE PER CELL (MDT)
C     HERE WHEN IMDOT = -1 IN DATA.
C-----------------------------------------------------------------------
 1500 CONTINUE
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 16: SET HERE PHASE 1 & 2 SATURATION ENTHALPIES
C     ( HST1 & HST2) WHEN IHSAT = -1 IN DATA.
C-----------------------------------------------------------------------
 1600 CONTINUE
      RETURN
```

END

APPENDIX C

INPUT FILE FOR PROGRAM CALCULATING LAMINAR FLOW QUANTITIES

H(IZ)	W(IZ)	RO(IZ)	P(IZ)	V(IZ)
5.518E+05	7.003E+02	2.303	1.424E+05	4.885E+05
5.071E+05	5.741E+02	2.313	1.432E+05	4.044E+01
4.711E+05	4.617E+02	2.310	1.430E+05	3.256E+01
4.318E+05	3.128E+02	2.293	1.416E+05	2.206E+01
4.116E+05	2.181E+02	2.294	1.416E+05	1.536E+01
4.039E+05	1.725E+02	2.300	1.421E+05	1.210E+01
4.016E+05	1.564E+02	2.303	1.424E+05	1.094E+01
4.010E+05	1.519E+02	2.302	1.423E+05	1.060E+01
4.006E+05	1.510E+02	2.300	1.422E+05	1.053E+01
4.554E+05	3.734E+02	2.295	1.417E+05	2.540E+01
4.294E+05	2.878E+02	2.297	1.419E+05	2.032E+01
4.225E+05	2.643E+02	2.292	1.415E+05	1.870E+01
4.168E+05	2.470E+02	2.282	1.407E+05	1.742E+01
4.769E+05	4.863E+02	2.242	1.374E+05	3.130E+01
4.646E+05	4.447E+02	1.827	1.042E+05	1.723E+00

APPENDIX D

LAMINAR OUTPUT FLOW FIELD

```
DATA TAKEN FROM DEFAULT.DTA ON GROUP A/C
FILE MODSTL.FTN IS THE SATLIT USED.

        BODY-FITTED-CCORDINATE OPTION ACTIVE
        ------------------------------------
        F1 ARRAY IS DIMENSIONED TO         =  5000
        MINIMUM ALLOWABLE DIMENSION FOR F1 =  1318


        THIS VERSION OF PHOENICS  MUST  BE USED
        IN ACCORDANCE WITH THE SPRING 1983 PHOENICS
        INSTRUCTION MANUAL
        (PHOENICS LAST AMENDED ON 04/12/84)


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        BODY-FITTED-COORDINATE OPTION ACTIVE
        ------------------------------------
        F1 ARRAY IS DIMENSIONED TO         = 10000
        MINIMUM ALLOWABLE DIMENSION FOR F1 =  2700

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FLOW FIELD AT, ISWEEP= 100, ISTEP=   1
FIELD VALUES OF M
  IY=25   3.200E+00   3.200E+00   3.200E+00   3.200E+00   3.200E+00
  IY=24   3.200E+00   3.200E+00   3.200E+00   3.200E+00   3.200E+00
  IY=23   3.200E+00   3.200E+00   3.200E+00   3.200E+00   3.200E+00
  IY=22   3.200E+00   3.200E+00   3.200E+00   3.200E+00   3.200E+00
  IY=21   3.200E+00   3.200E+00   3.200E+00   3.200E+00   3.200E+00
  IY=20   3.200E+00   3.200E+00   3.200E+00   3.200E+00   3.200E+00
```

IY=19	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=18	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=17	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=16	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=15	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.199E+00
IY=14	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.199E+00
IY=13	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.199E+00
IY=12	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.199E+00
IY=11	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.199E+00
IY=10	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.199E+00
IY= 9	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.198E+00
IY= 8	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.198E+00
IY= 7	3.200E+00	3.200E+00	3.200E+00	3.199E+00	3.195E+00
IY= 6	3.200E+00	3.200E+00	3.200E+00	3.198E+00	3.185E+00
IY= 5	3.200E+00	3.200E+00	3.200E+00	3.196E+00	3.157E+00
IY= 4	3.200E+00	3.200E+00	3.200E+00	3.195E+00	3.135E+00
IY= 3	3.200E+00	3.200E+00	3.200E+00	3.195E+00	3.119E+00
IY= 2	3.200E+00	3.200E+00	3.200E+00	3.195E+00	3.110E+00
IY= 1	3.200E+00	3.200E+00	3.200E+00	3.195E+00	3.108E+00
IZ=	1	2	3	4	5
IY=25	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=24	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=23	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=22	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=21	3.200E+00	3.200E+00	3.200E+00	3.199E+00	3.199E+00
IY=20	3.199E+00	3.199E+00	3.199E+00	3.199E+00	3.199E+00
IY=19	3.199E+00	3.199E+00	3.199E+00	3.199E+00	3.199E+00
IY=18	3.199E+00	3.199E+00	3.199E+00	3.199E+00	3.198E+00
IY=17	3.199E+00	3.199E+00	3.199E+00	3.198E+00	3.198E+00
IY=16	3.198E+00	3.198E+00	3.198E+00	3.198E+00	3.197E+00
IY=15	3.198E+00	3.198E+00	3.198E+00	3.197E+00	3.195E+00
IY=14	3.197E+00	3.197E+00	3.197E+00	3.196E+00	3.192E+00
IY=13	3.197E+00	3.197E+00	3.196E+00	3.194E+00	3.187E+00
IY=12	3.197E+00	3.196E+00	3.195E+00	3.190E+00	3.178E+00
IY=11	3.196E+00	3.195E+00	3.193E+00	3.183E+00	3.163E+00

IY=10	3.195E+00	3.194E+00	3.188E+00	3.170E+00	3.139E+00
IY= 9	3.194E+00	3.191E+00	3.178E+00	3.147E+00	3.104E+00
IY= 8	3.191E+00	3.183E+00	3.158E+00	3.109E+00	3.062E+00
IY= 7	3.181E+00	3.160E+00	3.116E+00	3.058E+00	3.024E+00
IY= 6	3.148E+00	3.099E+00	3.046E+00	3.012E+00	3.005E+00
IY= 5	3.077E+00	3.027E+00	3.012E+00	3.011E+00	3.009E+00
IY= 4	3.033E+00	3.002E+00	3.001E+00	3.004E+00	3.003E+00
IY= 3	3.007E+00	2.993E+00	2.995E+00	2.996E+00	2.991E+00
IY= 2	2.992E+00	2.962E+00	2.931E+00	2.866E+00	2.803E+00
IY= 1	2.430E+00	1.991E+00	1.601E+00	1.086E+00	7.575E-01
IZ=	6	7	8	9	10
IY=25	3.200E+00	3.200E+00	3.199E+00	3.199E+00	3.199E+00
IY=24	3.200E+00	3.200E+00	3.199E+00	3.199E+00	3.199E+00
IY=23	3.200E+00	3.199E+00	3.199E+00	3.199E+00	3.198E+00
IY=22	3.199E+00	3.199E+00	3.199E+00	3.198E+00	3.197E+00
IY=21	3.199E+00	3.199E+00	3.198E+00	3.196E+00	3.195E+00
IY=20	3.199E+00	3.198E+00	3.196E+00	3.194E+00	3.192E+00
IY=19	3.198E+00	3.197E+00	3.194E+00	3.190E+00	3.187E+00
IY=18	3.197E+00	3.195E+00	3.190E+00	3.185E+00	3.180E+00
IY=17	3.196E+00	3.192E+00	3.185E+00	3.176E+00	3.169E+00
IY=16	3.194E+00	3.187E+00	3.176E+00	3.163E+00	3.153E+00
IY=15	3.190E+00	3.179E+00	3.163E+00	3.145E+00	3.132E+00
IY=14	3.183E+00	3.167E+00	3.144E+00	3.121E+00	3.106E+00
IY=13	3.173E+00	3.150E+00	3.120E+00	3.094E+00	3.078E+00
IY=12	3.156E+00	3.125E+00	3.091E+00	3.065E+00	3.052E+00
IY=11	3.132E+00	3.095E+00	3.062E+00	3.041E+00	3.032E+00
IY=10	3.100E+00	3.063E+00	3.036E+00	3.024E+00	3.019E+00
IY= 9	3.063E+00	3.034E+00	3.019E+00	3.013E+00	3.013E+00
IY= 8	3.030E+00	3.015E+00	3.010E+00	3.009E+00	3.010E+00
IY= 7	3.010E+00	3.007E+00	3.007E+00	3.008E+00	3.009E+00
IY= 6	3.005E+00	3.006E+00	3.006E+00	3.007E+00	3.009E+00
IY= 5	3.008E+00	3.007E+00	3.008E+00	3.009E+00	3.011E+00
IY= 4	3.001E+00	3.001E+00	3.001E+00	3.002E+00	3.004E+00
IY= 3	2.987E+00	2.983E+00	2.981E+00	2.979E+00	2.980E+00
IY= 2	2.753E+00	2.713E+00	2.678E+00	2.644E+00	2.645E+00

IY= 1	5.988E-01	5.427E-01	5.271E-01	5.239E-01	1.296E+00
IZ=	11	12	13	14	15
IY=25	3.199E+00	3.199E+00	3.199E+00	3.199E+00	3.199E+00
IY=24	3.198E+00	3.198E+00	3.198E+00	3.198E+00	3.198E+00
IY=23	3.198E+00	3.198E+00	3.198E+00	3.198E+00	3.198E+00
IY=22	3.196E+00	3.196E+00	3.196E+00	3.196E+00	3.196E+00
IY=21	3.194E+00	3.194E+00	3.194E+00	3.194E+00	3.194E+00
IY=20	3.190E+00	3.190E+00	3.190E+00	3.190E+00	3.190E+00
IY=19	3.185E+00	3.184E+00	3.184E+00	3.184E+00	3.184E+00
IY=18	3.176E+00	3.175E+00	3.174E+00	3.174E+00	3.175E+00
IY=17	3.163E+00	3.162E+00	3.161E+00	3.160E+00	3.161E+00
IY=16	3.146E+00	3.144E+00	3.142E+00	3.141E+00	3.143E+00
IY=15	3.123E+00	3.120E+00	3.118E+00	3.117E+00	3.119E+00
IY=14	3.096E+00	3.093E+00	3.091E+00	3.090E+00	3.093E+00
IY=13	3.068E+00	3.066E+00	3.065E+00	3.064E+00	3.068E+00
IY=12	3.045E+00	3.043E+00	3.043E+00	3.044E+00	3.049E+00
IY=11	3.028E+00	3.028E+00	3.029E+00	3.031E+00	3.037E+00
IY=10	3.018E+00	3.019E+00	3.022E+00	3.024E+00	3.031E+00
IY= 9	3.014E+00	3.016E+00	3.019E+00	3.022E+00	3.029E+00
IY= 8	3.012E+00	3.015E+00	3.018E+00	3.021E+00	3.028E+00
IY= 7	3.011E+00	3.014E+00	3.017E+00	3.020E+00	3.028E+00
IY= 6	3.011E+00	3.013E+00	3.017E+00	3.021E+00	3.030E+00
IY= 5	3.012E+00	3.014E+00	3.019E+00	3.030E+00	3.052E+00
IY= 4	3.004E+00	3.007E+00	3.013E+00	3.038E+00	3.077E+00
IY= 3	2.976E+00	2.978E+00	2.986E+00	3.033E+00	3.081E+00
IY= 2	2.606E+00	2.597E+00	2.599E+00	2.686E+00	2.738E+00
IY= 1	9.991E-01	9.179E-01	8.583E-01	1.695E+00	1.603E+00
IZ=	16	17	18	19	20
IY=25	3.194E+00	3.194E+00			
IY=24	3.154E+00	3.154E+00			
IY=23	3.077E+00	3.078E+00			
IY=22	2.972E+00	2.973E+00			
IY=21	2.846E+00	2.849E+00			
IY=20	2.707E+00	2.712E+00			
IY=19	2.561E+00	2.569E+00			

IY=18	2.412E+00	2.424E+00
IY=17	2.262E+00	2.279E+00
IY=16	2.112E+00	2.137E+00
IY=15	1.963E+00	1.996E+00
IY=14	1.819E+00	1.858E+00
IY=13	1.683E+00	1.728E+00
IY=12	1.562E+00	1.609E+00
IY=11	1.458E+00	1.503E+00
IY=10	1.368E+00	1.411E+00
IY= 9	1.291E+00	1.330E+00
IY= 8	1.222E+00	1.257E+00
IY= 7	1.160E+00	1.189E+00
IY= 6	1.104E+00	1.126E+00
IY= 5	1.079E+00	1.091E+00
IY= 4	1.087E+00	1.095E+00
IY= 3	1.112E+00	1.116E+00
IY= 2	1.035E+00	1.040E+00
IY= 1	5.906E-01	6.047E-01
IZ=	21	22

FIELD VALUES OF T (temperature)

IY=25	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=24	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=23	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=22	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=21	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=20	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=19	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=18	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=17	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.991E+02
IY=16	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.991E+02
IY=15	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.991E+02
IY=14	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.991E+02
IY=13	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.992E+02
IY=12	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.992E+02
IY=11	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.992E+02

IY=10	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.993E+02
IY= 9	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.993E+02
IY= 8	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.995E+02
IY= 7	1.990E+02	1.990E+02	1.990E+02	1.991E+02	1.999E+02
IY= 6	1.990E+02	1.990E+02	1.990E+02	1.993E+02	2.017E+02
IY= 5	1.990E+02	1.990E+02	1.990E+02	1.997E+02	2.073E+02
IY= 4	1.990E+02	1.990E+02	1.990E+02	1.999E+02	2.117E+02
IY= 3	1.990E+02	1.990E+02	1.991E+02	1.999E+02	2.153E+02
IY= 2	1.990E+02	1.990E+02	1.991E+02	1.999E+02	2.172E+02
IY= 1	1.990E+02	1.990E+02	1.991E+02	1.999E+02	2.176E+02
IZ=	1	2	3	4	5
IY=25	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=24	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=23	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=22	1.990E+02	1.990E+02	1.991E+02	1.991E+02	1.991E+02
IY=21	1.991E+02	1.991E+02	1.991E+02	1.991E+02	1.991E+02
IY=20	1.991E+02	1.991E+02	1.991E+02	1.991E+02	1.992E+02
IY=19	1.992E+02	1.992E+02	1.992E+02	1.992E+02	1.992E+02
IY=18	1.992E+02	1.992E+02	1.992E+02	1.992E+02	1.993E+02
IY=17	1.993E+02	1.993E+02	1.993E+02	1.993E+02	1.994E+02
IY=16	1.994E+02	1.994E+02	1.994E+02	1.994E+02	1.996E+02
IY=15	1.994E+02	1.995E+02	1.995E+02	1.996E+02	1.999E+02
IY=14	1.995E+02	1.995E+02	1.996E+02	1.998E+02	2.003E+02
IY=13	1.996E+02	1.997E+02	1.998E+02	2.001E+02	2.010E+02
IY=12	1.997E+02	1.998E+02	2.000E+02	2.007E+02	2.021E+02
IY=11	1.999E+02	1.999E+02	2.004E+02	2.016E+02	2.038E+02
IY=10	2.000E+02	2.002E+02	2.012E+02	2.033E+02	2.063E+02
IY= 9	2.003E+02	2.007E+02	2.027E+02	2.059E+02	2.095E+02
IY= 8	2.008E+02	2.018E+02	2.055E+02	2.097E+02	2.128E+02
IY= 7	2.022E+02	2.045E+02	2.100E+02	2.136E+02	2.149E+02
IY= 6	2.065E+02	2.108E+02	2.151E+02	2.156E+02	2.152E+02
IY= 5	2.134E+02	2.148E+02	2.144E+02	2.143E+02	2.145E+02
IY= 4	2.167E+02	2.165E+02	2.157E+02	2.157E+02	2.160E+02
IY= 3	2.178E+02	2.173E+02	2.167E+02	2.171E+02	2.178E+02
IY= 2	2.181E+02	2.210E+02	2.244E+02	2.328E+02	2.404E+02

IY= 1	2.759E+02	3.085E+02	3.288E+02	3.456E+02	3.503E+02
IZ=	6	7	8	9	10
IY=25	1.990E+02	1.990E+02	1.991E+02	1.991E+02	1.991E+02
IY=24	1.990E+02	1.990E+02	1.991E+02	1.991E+02	1.991E+02
IY=23	1.990E+02	1.991E+02	1.991E+02	1.992E+02	1.992E+02
IY=22	1.991E+02	1.991E+02	1.992E+02	1.993E+02	1.993E+02
IY=21	1.991E+02	1.992E+02	1.993E+02	1.994E+02	1.995E+02
IY=20	1.992E+02	1.993E+02	1.995E+02	1.996E+02	1.998E+02
IY=19	1.993E+02	1.995E+02	1.998E+02	2.000E+02	2.003E+02
IY=18	1.994E+02	1.997E+02	2.002E+02	2.006E+02	2.009E+02
IY=17	1.996E+02	2.001E+02	2.009E+02	2.014E+02	2.020E+02
IY=16	2.000E+02	2.007E+02	2.019E+02	2.025E+02	2.033E+02
IY=15	2.005E+02	2.016E+02	2.032E+02	2.042E+02	2.052E+02
IY=14	2.013E+02	2.029E+02	2.051E+02	2.062E+02	2.074E+02
IY=13	2.025E+02	2.047E+02	2.073E+02	2.085E+02	2.096E+02
IY=12	2.043E+02	2.070E+02	2.097E+02	2.107E+02	2.116E+02
IY=11	2.067E+02	2.096E+02	2.118E+02	2.125E+02	2.130E+02
IY=10	2.095E+02	2.120E+02	2.134E+02	2.136E+02	2.137E+02
IY= 9	2.123E+02	2.138E+02	2.142E+02	2.142E+02	2.140E+02
IY= 8	2.143E+02	2.146E+02	2.146E+02	2.144E+02	2.142E+02
IY= 7	2.150E+02	2.149E+02	2.148E+02	2.146E+02	2.144E+02
IY= 6	2.150E+02	2.150E+02	2.149E+02	2.147E+02	2.145E+02
IY= 5	2.146E+02	2.146E+02	2.145E+02	2.143E+02	2.142E+02
IY= 4	2.161E+02	2.161E+02	2.160E+02	2.158E+02	2.158E+02
IY= 3	2.182E+02	2.186E+02	2.188E+02	2.189E+02	2.190E+02
IY= 2	2.459E+02	2.500E+02	2.534E+02	2.565E+02	2.566E+02
IY= 1	3.514E+02	3.517E+02	3.517E+02	3.516E+02	3.481E+02
IZ=	11	12	13	14	15
IY=25	1.991E+02	1.991E+02	1.991E+02	1.991E+02	1.991E+02
IY=24	1.991E+02	1.991E+02	1.991E+02	1.991E+02	1.991E+02
IY=23	1.992E+02	1.992E+02	1.992E+02	1.992E+02	1.992E+02
IY=22	1.993E+02	1.993E+02	1.993E+02	1.993E+02	1.993E+02
IY=21	1.995E+02	1.995E+02	1.995E+02	1.995E+02	1.994E+02
IY=20	1.998E+02	1.999E+02	1.999E+02	1.998E+02	1.997E+02
IY=19	2.003E+02	2.003E+02	2.004E+02	2.003E+02	2.001E+02

IY=18	2.010E+02	2.011E+02	2.011E+02	2.010E+02	2.008E+02
IY=17	2.020E+02	2.021E+02	2.022E+02	2.021E+02	2.018E+02
IY=16	2.034E+02	2.036E+02	2.036E+02	2.036E+02	2.032E+02
IY=15	2.053E+02	2.054E+02	2.055E+02	2.055E+02	2.049E+02
IY=14	2.075E+02	2.076E+02	2.077E+02	2.077E+02	2.070E+02
IY=13	2.097E+02	2.098E+02	2.097E+02	2.097E+02	2.089E+02
IY=12	2.115E+02	2.115E+02	2.114E+02	2.113E+02	2.104E+02
IY=11	2.128E+02	2.126E+02	2.124E+02	2.123E+02	2.114E+02
IY=10	2.135E+02	2.132E+02	2.129E+02	2.127E+02	2.119E+02
IY= 9	2.138E+02	2.135E+02	2.131E+02	2.129E+02	2.121E+02
IY= 8	2.139E+02	2.136E+02	2.132E+02	2.130E+02	2.123E+02
IY= 7	2.141E+02	2.138E+02	2.134E+02	2.132E+02	2.124E+02
IY= 6	2.143E+02	2.140E+02	2.135E+02	2.131E+02	2.122E+02
IY= 5	2.140E+02	2.137E+02	2.130E+02	2.114E+02	2.094E+02
IY= 4	2.156E+02	2.152E+02	2.141E+02	2.102E+02	2.080E+02
IY= 3	2.193E+02	2.190E+02	2.175E+02	2.094E+02	2.112E+02
IY= 2	2.605E+02	2.613E+02	2.605E+02	2.470E+02	2.516E+02
IY= 1	3.503E+02	3.499E+02	3.488E+02	3.236E+02	3.304E+02
IZ=	16	17	18	19	20
IY=25	2.002E+02	2.002E+02			
IY=24	2.091E+02	2.091E+02			
IY=23	2.255E+02	2.255E+02			
IY=22	2.476E+02	2.476E+02			
IY=21	2.729E+02	2.729E+02			
IY=20	2.994E+02	2.994E+02			
IY=19	3.258E+02	3.257E+02			
IY=18	3.510E+02	3.507E+02			
IY=17	3.747E+02	3.742E+02			
IY=16	3.967E+02	3.957E+02			
IY=15	4.170E+02	4.151E+02			
IY=14	4.355E+02	4.320E+02			
IY=13	4.518E+02	4.456E+02			
IY=12	4.655E+02	4.546E+02			
IY=11	4.768E+02	4.577E+02			
IY=10	4.861E+02	4.532E+02			

IY= 9	4.937E+02	4.381E+02
IY= 8	5.001E+02	4.070E+02
IY= 7	5.056E+02	3.546E+02
IY= 6	5.103E+02	2.656E+02
IY= 5	5.128E+02	1.176E+02
IY= 4	5.123E+02	4.260E+01
IY= 3	5.065E+02	-7.998E+00
IY= 2	4.754E+02	-2.779E+01
IY= 1	3.969E+02	-1.017E+01
IZ=	21	22

FIELD VALUES OF H1

IY=25	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=24	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=23	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=22	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=21	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=20	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=19	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=18	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=17	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=16	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=15	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=14	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=13	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=12	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=11	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=10	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 9	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 8	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 7	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 6	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 5	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 4	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 3	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 2	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05

IY= 1	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IZ=	1	2	3	4	5
IY=25	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=24	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=23	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=22	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=21	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=20	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=19	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=18	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=17	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=16	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=15	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=14	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=13	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=12	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=11	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=10	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 9	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 8	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 7	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 6	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 5	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 4	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 3	6.150E+05	6.150E+05	6.149E+05	6.145E+05	6.141E+05
IY= 2	6.144E+05	6.114E+05	6.075E+05	6.001E+05	5.935E+05
IY= 1	5.518E+05	5.071E+05	4.711E+05	4.318E+05	4.116E+05
IZ=	6	7	8	9	10
IY=25	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=24	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=23	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=22	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=21	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=20	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=19	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05

IY=18	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=17	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=16	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=15	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=14	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=13	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=12	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=11	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=10	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 9	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 8	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 7	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 6	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 5	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 4	6.150E+05	6.149E+05	6.149E+05	6.149E+05	6.149E+05
IY= 3	6.137E+05	6.134E+05	6.130E+05	6.127E+05	6.126E+05
IY= 2	5.883E+05	5.838E+05	5.797E+05	5.757E+05	5.755E+05
IY= 1	4.039E+05	4.016E+05	4.010E+05	4.006E+05	4.554E+05
IZ=	11	12	13	14	15
IY=25	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=24	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=23	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=22	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=21	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=20	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=19	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=18	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=17	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=16	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=15	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=14	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=13	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=12	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=11	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=10	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05

IY= 9	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 8	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 7	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 6	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 5	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.149E+05
IY= 4	6.149E+05	6.149E+05	6.149E+05	6.149E+05	6.144E+05
IY= 3	6.121E+05	6.120E+05	6.119E+05	6.119E+05	6.093E+05
IY= 2	5.715E+05	5.704E+05	5.694E+05	5.713E+05	5.686E+05
IY= 1	4.294E+05	4.225E+05	4.168E+05	4.769E+05	4.646E+05
IZ=	16	17	18	19	20
IY=25	6.150E+05	6.150E+05			
IY=24	6.150E+05	6.150E+05			
IY=23	6.150E+05	6.150E+05			
IY=22	6.150E+05	6.150E+05			
IY=21	6.150E+05	6.150E+05			
IY=20	6.150E+05	6.150E+05			
IY=19	6.150E+05	6.149E+05			
IY=18	6.150E+05	6.148E+05			
IY=17	6.150E+05	6.145E+05			
IY=16	6.150E+05	6.140E+05			
IY=15	6.150E+05	6.131E+05			
IY=14	6.150E+05	6.114E+05			
IY=13	6.150E+05	6.083E+05			
IY=12	6.150E+05	6.030E+05			
IY=11	6.150E+05	5.938E+05			
IY=10	6.150E+05	5.785E+05			
IY= 9	6.150E+05	5.532E+05			
IY= 8	6.150E+05	5.123E+05			
IY= 7	6.150E+05	4.471E+05			
IY= 6	6.150E+05	3.429E+05			
IY= 5	6.149E+05	1.761E+05			
IY= 4	6.142E+05	9.337E+04			
IY= 3	6.088E+05	3.912E+04			
IY= 2	5.677E+05	1.068E+04			
IY= 1	4.528E+05	2.236E+03			

IZ=	21	22			
FIELD VALUES OF VRES					
IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	1.405E-05	3.007E-06	-5.550E-06	-1.294E-04	-1.448E-03
IY=23	-1.959E-05	-4.107E-06	8.235E-06	-4.790E-05	-3.747E-04
IY=22	2.043E-05	-5.721E-07	-2.893E-05	-9.892E-05	-9.914E-05
IY=21	-5.591E-10	3.131E-08	1.097E-06	-2.957E-06	-2.073E-04
IY=20	-2.045E-05	6.139E-07	2.518E-05	7.661E-05	1.586E-04
IY=19	1.929E-05	5.354E-06	-2.818E-05	4.812E-05	1.744E-04
IY=18	-1.987E-05	1.297E-05	4.382E-05	2.561E-05	3.570E-05
IY=17	6.476E-06	-2.901E-06	2.098E-05	-2.651E-05	-1.529E-04
IY=16	1.378E-05	-7.195E-05	-9.990E-05	-9.397E-05	5.056E-06
IY=15	-1.977E-05	5.437E-05	7.165E-05	1.332E-04	1.717E-04
IY=14	1.896E-05	3.793E-05	1.053E-04	9.233E-05	6.895E-05
IY=13	-1.845E-05	-6.689E-06	9.738E-07	3.035E-05	1.767E-04
IY=12	1.975E-05	1.183E-05	1.163E-04	1.505E-04	6.171E-04
IY=11	3.013E-07	2.053E-05	3.482E-05	3.487E-04	1.606E-03
IY=10	-2.003E-05	-3.403E-05	1.106E-04	9.926E-04	5.410E-03
IY= 9	1.904E-05	2.851E-05	4.678E-04	2.726E-03	1.652E-02
IY= 8	1.642E-06	5.153E-05	8.444E-04	7.499E-03	5.295E-02
IY= 7	-4.829E-06	2.910E-04	2.275E-03	2.092E-02	1.693E-01
IY= 6	1.053E-04	2.549E-04	4.145E-03	4.924E-02	5.166E-01
IY= 5	-1.989E-04	4.910E-05	4.310E-03	7.840E-02	1.314E+00
IY= 4	-1.164E-04	-1.745E-04	2.356E-03	5.204E-02	1.232E+00
IY= 3	-1.059E-05	3.473E-06	1.181E-03	2.448E-02	7.443E-01
IY= 2	-8.491E-06	4.780E-06	1.770E-04	6.999E-03	2.625E-01
IY= 1	-8.910E-07	1.790E-07	2.166E-05	1.920E-03	3.539E-02
IZ=	1	2	3	4	5
IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	-3.953E-03	-4.269E-03	-2.334E-03	2.271E-03	3.218E-03
IY=23	-1.181E-03	-2.523E-03	-3.031E-03	-8.488E-04	2.689E-03
IY=22	-5.793E-04	-9.827E-04	-1.593E-03	-7.053E-04	3.140E-03
IY=21	-2.258E-04	-2.051E-04	-2.464E-04	2.080E-04	5.418E-03
IY=20	-3.934E-05	-2.173E-04	-4.561E-04	1.301E-03	1.130E-02
IY=19	3.721E-04	-4.902E-05	-5.433E-06	3.314E-03	2.218E-02

IY=18	3.182E-05	2.607E-04	3.912E-04	7.727E-03	4.387E-02
IY=17	-2.040E-04	-4.925E-05	9.271E-04	1.625E-02	8.650E-02
IY=16	-2.034E-05	2.115E-04	2.349E-03	3.314E-02	1.688E-01
IY=15	1.918E-04	5.597E-04	4.625E-03	6.814E-02	3.306E-01
IY=14	3.685E-04	1.909E-03	1.063E-02	1.413E-01	6.499E-01
IY=13	9.120E-04	4.141E-03	2.383E-02	2.970E-01	1.279E+00
IY=12	2.347E-03	1.078E-02	5.622E-02	6.341E-01	2.512E+00
IY=11	7.212E-03	3.105E-02	1.401E-01	1.369E+00	4.888E+00
IY=10	2.337E-02	9.418E-02	3.674E-01	2.980E+00	9.307E+00
IY= 9	7.721E-02	2.995E-01	1.019E+00	6.466E+00	1.700E+01
IY= 8	2.654E-01	9.986E-01	2.959E+00	1.367E+01	2.890E+01
IY= 7	9.643E-01	3.454E+00	8.743E+00	2.698E+01	4.385E+01
IY= 6	3.755E+00	1.203E+01	2.444E+01	4.618E+01	5.672E+01
IY= 5	1.654E+01	3.910E+01	5.510E+01	6.130E+01	6.067E+01
IY= 4	3.314E+01	5.331E+01	5.999E+01	6.139E+01	6.069E+01
IY= 3	4.758E+01	5.910E+01	6.080E+01	6.092E+01	6.046E+01
IY= 2	5.655E+01	5.995E+01	5.954E+01	5.810E+01	5.665E+01
IY= 1	4.885E+01	4.044E+01	3.256E+01	2.206E+01	1.536E+01
IZ=	6	7	8	9	10
IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	4.446E-03	1.170E-02	3.426E-02	8.774E-02	1.266E-01
IY=23	9.023E-03	2.744E-02	7.989E-02	2.031E-01	2.905E-01
IY=22	1.510E-02	5.126E-02	1.508E-01	3.776E-01	5.369E-01
IY=21	2.656E-02	9.261E-02	2.685E-01	6.585E-01	9.301E-01
IY=20	4.939E-02	1.664E-01	4.690E-01	1.120E+00	1.569E+00
IY=19	9.180E-02	2.983E-01	8.128E-01	1.879E+00	2.604E+00
IY=18	1.719E-01	5.349E-01	1.398E+00	3.108E+00	4.251E+00
IY=17	3.217E-01	9.547E-01	2.379E+00	5.057E+00	6.805E+00
IY=16	5.993E-01	1.691E+00	3.996E+00	8.053E+00	1.062E+01
IY=15	1.114E+00	2.967E+00	6.586E+00	1.246E+01	1.603E+01
IY=14	2.059E+00	5.127E+00	1.058E+01	1.857E+01	2.316E+01
IY=13	3.767E+00	8.660E+00	1.640E+01	2.638E+01	3.173E+01
IY=12	6.770E+00	1.414E+01	2.423E+01	3.536E+01	4.081E+01
IY=11	1.181E+01	2.202E+01	3.369E+01	4.434E+01	4.889E+01
IY=10	1.967E+01	3.214E+01	4.363E+01	5.188E+01	5.500E+01

IY= 9	3.056E+01	4.321E+01	5.208E+01	5.706E+01	5.867E+01
IY= 8	4.318E+01	5.281E+01	5.768E+01	5.971E+01	6.023E+01
IY= 7	5.420E+01	5.868E+01	6.013E+01	6.049E+01	6.053E+01
IY= 6	5.992E+01	6.049E+01	6.053E+01	6.052E+01	6.048E+01
IY= 5	6.032E+01	6.046E+01	6.058E+01	6.059E+01	6.038E+01
IY= 4	6.035E+01	6.038E+01	6.044E+01	6.045E+01	6.004E+01
IY= 3	6.018E+01	6.009E+01	6.004E+01	5.999E+01	5.938E+01
IY= 2	5.551E+01	5.466E+01	5.393E+01	5.325E+01	5.253E+01
IY= 1	1.210E+01	1.094E+01	1.060E+01	1.053E+01	2.540E+01
IZ=	11	12	13	14	15
IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	1.811E-01	1.958E-01	2.111E-01	2.271E-01	2.430E-01
IY=23	4.099E-01	4.423E-01	4.760E-01	5.105E-01	5.461E-01
IY=22	7.520E-01	8.107E-01	8.717E-01	9.344E-01	9.998E-01
IY=21	1.293E+00	1.393E+00	1.497E+00	1.603E+00	1.716E+00
IY=20	2.163E+00	2.326E+00	2.497E+00	2.672E+00	2.860E+00
IY=19	3.550E+00	3.811E+00	4.083E+00	4.363E+00	4.669E+00
IY=18	5.718E+00	6.122E+00	6.542E+00	6.976E+00	7.458E+00
IY=17	9.000E+00	9.602E+00	1.023E+01	1.087E+01	1.160E+01
IY=16	1.375E+01	1.460E+01	1.549E+01	1.639E+01	1.743E+01
IY=15	2.021E+01	2.133E+01	2.249E+01	2.367E+01	2.502E+01
IY=14	2.827E+01	2.963E+01	3.101E+01	3.241E+01	3.396E+01
IY=13	3.726E+01	3.871E+01	4.013E+01	4.151E+01	4.298E+01
IY=12	4.577E+01	4.702E+01	4.822E+01	4.934E+01	5.051E+01
IY=11	5.262E+01	5.353E+01	5.436E+01	5.512E+01	5.587E+01
IY=10	5.724E+01	5.776E+01	5.822E+01	5.861E+01	5.898E+01
IY= 9	5.965E+01	5.987E+01	6.003E+01	6.016E+01	6.027E+01
IY= 8	6.046E+01	6.050E+01	6.052E+01	6.053E+01	6.052E+01
IY= 7	6.052E+01	6.051E+01	6.050E+01	6.049E+01	6.046E+01
IY= 6	6.046E+01	6.045E+01	6.045E+01	6.043E+01	6.029E+01
IY= 5	6.046E+01	6.051E+01	6.056E+01	6.039E+01	5.879E+01
IY= 4	6.046E+01	6.061E+01	6.064E+01	5.964E+01	5.160E+01
IY= 3	6.012E+01	6.025E+01	6.021E+01	5.819E+01	3.630E+01
IY= 2	5.278E+01	5.265E+01	5.248E+01	5.058E+01	1.374E+01
IY= 1	2.032E+01	1.870E+01	1.742E+01	3.130E+01	1.723E+00

IZ=	16	17	18	19	20
IY=25	0.000E+00	0.000E+00			
IY=24	2.563E-01	3.246E-01			
IY=23	5.777E-01	7.707E-01			
IY=22	1.059E+00	1.522E+00			
IY=21	1.818E+00	2.799E+00			
IY=20	3.032E+00	4.892E+00			
IY=19	4.946E+00	8.121E+00			
IY=18	7.898E+00	1.278E+01			
IY=17	1.226E+01	1.897E+01			
IY=16	1.837E+01	2.654E+01			
IY=15	2.624E+01	3.486E+01			
IY=14	3.533E+01	4.297E+01			
IY=13	4.425E+01	4.971E+01			
IY=12	5.150E+01	5.427E+01			
IY=11	5.650E+01	5.650E+01			
IY=10	5.928E+01	5.655E+01			
IY= 9	6.035E+01	5.466E+01			
IY= 8	6.052E+01	5.086E+01			
IY= 7	6.042E+01	4.463E+01			
IY= 6	5.999E+01	3.476E+01			
IY= 5	5.595E+01	1.921E+01			
IY= 4	4.130E+01	4.419E+00			
IY= 3	1.798E+01	-9.836E-01			
IY= 2	2.057E+00	-2.496E+00			
IY= 1	1.768E-01	-3.095E+00			
IZ=	21	22			

FIELD VALUES OF VORT

IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	1.405E-05	3.007E-06	-5.550E-06	-1.294E-04	-1.450E-03
IY=23	-1.959E-05	-4.107E-06	8.235E-06	-4.790E-05	-3.780E-04
IY=22	2.043E-05	-5.721E-07	-2.893E-05	-9.892E-05	-1.024E-04
IY=21	-5.591E-10	3.131E-08	1.097E-06	-2.957E-06	-2.106E-04
IY=20	-2.045E-05	6.139E-07	2.518E-05	7.661E-05	1.520E-04
IY=19	1.929E-05	5.354E-06	-2.818E-05	4.812E-05	1.644E-04

IY=18	-1.987E-05	1.297E-05	4.382E-05	2.561E-05	3.570E-05
IY=17	6.476E-06	-2.901E-06	2.098E-05	-2.651E-05	-1.529E-04
IY=16	1.378E-05	-7.195E-05	-9.990E-05	-9.397E-05	1.746E-06
IY=15	-1.977E-05	5.437E-05	7.146E-05	1.332E-04	1.651E-04
IY=14	1.896E-05	3.793E-05	1.053E-04	9.233E-05	5.902E-05
IY=13	-1.845E-05	-6.689E-06	9.738E-07	3.035E-05	1.634E-04
IY=12	1.975E-05	1.183E-05	1.163E-04	1.505E-04	5.972E-04
IY=11	3.013E-07	2.053E-05	3.482E-05	3.487E-04	1.602E-03
IY=10	-2.003E-05	-3.403E-05	1.106E-04	9.926E-04	5.400E-03
IY= 9	1.904E-05	2.851E-05	4.678E-04	2.726E-03	1.650E-02
IY= 8	1.642E-06	5.153E-05	8.444E-04	7.499E-03	5.292E-02
IY= 7	-4.829E-06	2.910E-04	2.275E-03	2.092E-02	1.693E-01
IY= 6	1.053E-04	2.549E-04	4.145E-03	4.924E-02	5.166E-01
IY= 5	-1.989E-04	4.910E-05	4.310E-03	7.840E-02	1.314E+00
IY= 4	-1.164E-04	-1.745E-04	2.356E-03	5.204E-02	1.232E+00
IY= 3	-1.059E-05	3.473E-06	1.181E-03	2.448E-02	7.443E-01
IY= 2	-8.491E-06	4.780E-06	1.770E-04	6.999E-03	2.625E-01
IY= 1	-8.910E-07	1.790E-07	2.166E-05	1.920E-03	3.545E-02
IZ=	1	2	3	4	5
IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	-3.953E-03	-4.269E-03	-2.334E-03	2.271E-03	3.218E-03
IY=23	-1.181E-03	-2.523E-03	-3.031E-03	-8.521E-04	2.686E-03
IY=22	-5.826E-04	-9.861E-04	-1.597E-03	-7.087E-04	3.140E-03
IY=21	-2.357E-04	-2.151E-04	-2.531E-04	2.014E-04	5.411E-03
IY=20	-4.927E-05	-2.306E-04	-4.561E-04	1.285E-03	1.129E-02
IY=19	3.688E-04	-5.564E-05	-8.742E-06	3.311E-03	2.218E-02
IY=18	2.520E-05	2.475E-04	3.713E-04	7.711E-03	4.386E-02
IY=17	-2.205E-04	-5.917E-05	9.205E-04	[illegible]	8.648E-02
IY=16	-4.350E-05	1.917E-04	2.332E-03	3.312E-02	1.688E-01
IY=15	1.852E-04	5.531E-04	4.612E-03	6.814E-02	3.306E-01
IY=14	3.420E-04	1.909E-03	1.062E-02	1.412E-01	6.499E-01
IY=13	8.988E-04	4.108E-03	2.381E-02	2.970E-01	1.279E+00
IY=12	2.334E-03	1.076E-02	5.621E-02	6.341E-01	2.512E+00
IY=11	7.195E-03	3.104E-02	1.401E-01	1.369E+00	4.888E+00
IY=10	2.337E-02	9.416E-02	3.673E-01	2.980E+00	9.307E+00

IY= 9	7.721E-02	2.995E-01	1.019E+00	6.466E+00	1.700E+01
IY= 8	2.654E-01	9.985E-01	2.959E+00	1.367E+01	2.890E+01
IY= 7	9.642E-01	3.454E+00	8.743E+00	2.698E+01	4.385E+01
IY= 6	3.755E+00	1.203E+01	2.444E+01	4.618E+01	5.672E+01
IY= 5	1.654E+01	3.910E+01	5.510E+01	6.130E+01	6.067E+01
IY= 4	3.314E+01	5.331E+01	5.999E+01	6.139E+01	6.069E+01
IY= 3	4.758E+01	5.910E+01	6.080E+01	6.092E+01	6.046E+01
IY= 2	5.655E+01	5.995E+01	5.954E+01	5.810E+01	5.664E+01
IY= 1	4.885E+01	4.044E+01	3.256E+01	2.206E+01	1.536E+01
IZ=	6	7	8	9	10
IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	4.446E-03	1.170E-02	3.426E-02	8.774E-02	1.266E-01
IY=23	9.023E-03	2.744E-02	7.989E-02	2.031E-01	2.905E-01
IY=22	1.509E-02	5.126E-02	1.508E-01	3.776E-01	5.369E-01
IY=21	2.655E-02	9.261E-02	2.685E-01	6.585E-01	9.301E-01
IY=20	4.937E-02	1.664E-01	4.690E-01	1.120E+00	1.569E+00
IY=19	9.180E-02	2.983E-01	8.128E-01	1.879E+00	2.604E+00
IY=18	1.718E-01	5.349E-01	1.398E+00	3.108E+00	4.251E+00
IY=17	3.217E-01	9.547E-01	2.379E+00	5.057E+00	6.805E+00
IY=16	5.992E-01	1.691E+00	3.996E+00	8.053E+00	1.062E+01
IY=15	1.114E+00	2.967E+00	6.586E+00	1.246E+01	1.603E+01
IY=14	2.059E+00	5.127E+00	1.058E+01	1.857E+01	2.316E+01
IY=13	3.767E+00	8.660E+00	1.640E+01	2.638E+01	3.173E+01
IY=12	6.770E+00	1.414E+01	2.423E+01	3.536E+01	4.081E+01
IY=11	1.181E+01	2.202E+01	3.369E+01	4.434E+01	4.889E+01
IY=10	1.967E+01	3.213E+01	4.363E+01	5.188E+01	5.500E+01
IY= 9	3.056E+01	4.321E+01	5.208E+01	5.706E+01	5.867E+01
IY= 8	4.318E+01	5.281E+01	5.768E+01	5.971E+01	6.023E+01
IY= 7	5.420E+01	5.868E+01	6.013E+01	6.049E+01	6.053E+01
IY= 6	5.992E+01	6.049E+01	6.053E+01	6.052E+01	6.048E+01
IY= 5	6.032E+01	6.046E+01	6.058E+01	6.059E+01	6.038E+01
IY= 4	6.035E+01	6.038E+01	6.044E+01	6.045E+01	6.004E+01
IY= 3	6.018E+01	6.009E+01	6.004E+01	5.999E+01	5.938E+01
IY= 2	5.551E+01	5.466E+01	5.393E+01	5.325E+01	5.253E+01
IY= 1	1.210E+01	1.094E+01	1.060E+01	1.053E+01	2.540E+01

IZ=	11	12	13	14	15
IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	1.811E-01	1.958E-01	2.111E-01	2.271E-01	2.430E-01
IY=23	4.099E-01	4.423E-01	4.760E-01	5.105E-01	5.461E-01
IY=22	7.520E-01	8.107E-01	8.717E-01	9.344E-01	9.998E-01
IY=21	1.293E+00	1.393E+00	1.497E+00	1.603E+00	1.716E+00
IY=20	2.163E+00	2.326E+00	2.497E+00	2.672E+00	2.860E+00
IY=19	3.550E+00	3.811E+00	4.083E+00	4.363E+00	4.669E+00
IY=18	5.718E+00	6.122E+00	6.542E+00	6.976E+00	7.458E+00
IY=17	9.000E+00	9.602E+00	1.023E+01	1.087E+01	1.160E+01
IY=16	1.375E+01	1.460E+01	1.549E+01	1.639E+01	1.743E+01
IY=15	2.021E+01	2.133E+01	2.249E+01	2.367E+01	2.502E+01
IY=14	2.827E+01	2.963E+01	3.101E+01	3.241E+01	3.396E+01
IY=13	3.726E+01	3.871E+01	4.013E+01	4.151E+01	4.298E+01
IY=12	4.577E+01	4.702E+01	4.822E+01	4.934E+01	5.051E+01
IY=11	5.262E+01	5.352E+01	5.436E+01	5.512E+01	5.587E+01
IY=10	5.724E+01	5.776E+01	5.822E+01	5.861E+01	5.898E+01
IY= 9	5.965E+01	5.987E+01	6.003E+01	6.016E+01	6.027E+01
IY= 8	6.046E+01	6.050E+01	6.052E+01	6.053E+01	6.052E+01
IY= 7	6.052E+01	6.051E+01	6.050E+01	6.049E+01	6.046E+01
IY= 6	6.046E+01	6.045E+01	6.045E+01	6.043E+01	6.029E+01
IY= 5	6.046E+01	6.051E+01	6.056E+01	6.039E+01	5.879E+01
IY= 4	6.046E+01	6.061E+01	6.064E+01	5.964E+01	5.160E+01
IY= 3	6.012E+01	6.025E+01	6.021E+01	5.819E+01	3.630E+01
IY= 2	5.278E+01	5.265E+01	5.248E+01	5.058E+01	1.374E+01
IY= 1	2.032E+01	1.870E+01	1.742E+01	3.130E+01	1.723E+00

IZ=	16	17	18	19	20
IY=25	0.000E+00	0.000E+00			
IY=24	2.563E-01	3.246E-01			
IY=23	5.779E-01	7.709E-01			
IY=22	1.059E+00	1.522E+00			
IY=21	1.818E+00	2.800E+00			
IY=20	3.032E+00	4.892E+00			
IY=19	4.946E+00	8.121E+00			
IY=18	7.898E+00	1.278E+01			

IY=17	1.226E+01	1.897E+01
IY=16	1.837E+01	2.654E+01
IY=15	2.624E+01	3.486E+01
IY=14	3.534E+01	4.297E+01
IY=13	4.425E+01	4.971E+01
IY=12	5.150E+01	5.427E+01
IY=11	5.650E+01	5.650E+01
IY=10	5.928E+01	5.655E+01
IY= 9	6.035E+01	5.466E+01
IY= 8	6.052E+01	5.086E+01
IY= 7	6.042E+01	4.463E+01
IY= 6	5.999E+01	3.476E+01
IY= 5	5.595E+01	1.921E+01
IY= 4	4.130E+01	4.419E+00
IY= 3	1.798E+01	-9.833E-01
IY= 2	2.055E+00	-2.498E+00
IY= 1	1.738E-01	-3.098E+00
IZ=	21	22

FIELD VALUES OF WRES

IY=25	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=24	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=23	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=22	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=21	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=20	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=19	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=18	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=17	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=16	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=15	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=14	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.883E+02
IY=13	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.883E+02
IY=12	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.883E+02
IY=11	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.882E+02
IY=10	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.882E+02

IY= 9	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.881E+02
IY= 8	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.879E+02
IY= 7	8.885E+02	8.885E+02	8.885E+02	8.884E+02	8.873E+02
IY= 6	8.885E+02	8.885E+02	8.885E+02	8.881E+02	8.851E+02
IY= 5	8.885E+02	8.885E+02	8.884E+02	8.876E+02	8.781E+02
IY= 4	8.885E+02	8.885E+02	8.884E+02	8.874E+02	8.725E+02
IY= 3	8.885E+02	8.885E+02	8.884E+02	8.873E+02	8.679E+02
IY= 2	8.885E+02	8.885E+02	8.884E+02	8.873E+02	8.655E+02
IY= 1	8.885E+02	8.885E+02	8.884E+02	8.873E+02	8.650E+02
IZ=	1	2	3	4	5
IY=25	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=24	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=23	8.885E+02	8.885E+02	8.884E+02	8.884E+02	8.884E+02
IY=22	8.884E+02	8.884E+02	8.884E+02	8.884E+02	8.884E+02
IY=21	8.884E+02	8.884E+02	8.884E+02	8.884E+02	8.884E+02
IY=20	8.883E+02	8.883E+02	8.883E+02	8.883E+02	8.883E+02
IY=19	8.883E+02	8.883E+02	8.883E+02	8.882E+02	8.882E+02
IY=18	8.882E+02	8.882E+02	8.882E+02	8.882E+02	8.881E+02
IY=17	8.881E+02	8.881E+02	8.881E+02	8.881E+02	8.880E+02
IY=16	8.880E+02	8.880E+02	8.880E+02	8.879E+02	8.877E+02
IY=15	8.879E+02	8.879E+02	8.879E+02	8.878E+02	8.874E+02
IY=14	8.878E+02	8.878E+02	8.877E+02	8.875E+02	8.869E+02
IY=13	8.877E+02	8.877E+02	8.875E+02	8.871E+02	8.860E+02
IY=12	8.876E+02	8.875E+02	8.872E+02	8.864E+02	8.847E+02
IY=11	8.874E+02	8.873E+02	8.867E+02	8.852E+02	8.825E+02
IY=10	8.872E+02	8.870E+02	8.857E+02	8.831E+02	8.793E+02
IY= 9	8.869E+02	8.864E+02	8.839E+02	8.798E+02	8.751E+02
IY= 8	8.863E+02	8.850E+02	8.804E+02	8.750E+02	8.707E+02
IY= 7	8.845E+02	8.816E+02	8.746E+02	8.697E+02	8.673E+02
IY= 6	8.791E+02	8.736E+02	8.678E+02	8.663E+02	8.662E+02
IY= 5	8.702E+02	8.676E+02	8.673E+02	8.671E+02	8.668E+02
IY= 4	8.655E+02	8.648E+02	8.653E+02	8.652E+02	8.649E+02
IY= 3	8.635E+02	8.634E+02	8.638E+02	8.629E+02	8.616E+02
IY= 2	8.618E+02	8.544E+02	8.454E+02	8.254E+02	8.073E+02
IY= 1	7.003E+02	5.741E+02	4.617E+02	3.128E+02	2.181E+02

IZ=	6	7	8	9	10
IY=25	8.885E+02	8.884E+02	8.884E+02	8.884E+02	8.884E+02
IY=24	8.884E+02	8.884E+02	8.884E+02	8.884E+02	8.883E+02
IY=23	8.884E+02	8.884E+02	8.883E+02	8.883E+02	8.882E+02
IY=22	8.884E+02	8.883E+02	8.882E+02	8.882E+02	8.881E+02
IY=21	8.883E+02	8.882E+02	8.881E+02	8.880E+02	8.878E+02
IY=20	8.882E+02	8.881E+02	8.878E+02	8.877E+02	8.875E+02
IY=19	8.881E+02	8.879E+02	8.875E+02	8.872E+02	8.869E+02
IY=18	8.879E+02	8.876E+02	8.869E+02	8.865E+02	8.860E+02
IY=17	8.877E+02	8.871E+02	8.861E+02	8.855E+02	8.848E+02
IY=16	8.873E+02	8.864E+02	8.849E+02	8.840E+02	8.830E+02
IY=15	8.866E+02	8.852E+02	8.832E+02	8.819E+02	8.806E+02
IY=14	8.856E+02	8.836E+02	8.808E+02	8.793E+02	8.777E+02
IY=13	8.841E+02	8.813E+02	8.779E+02	8.762E+02	8.746E+02
IY=12	8.819E+02	8.783E+02	8.747E+02	8.730E+02	8.717E+02
IY=11	8.788E+02	8.749E+02	8.717E+02	8.704E+02	8.695E+02
IY=10	8.750E+02	8.715E+02	8.693E+02	8.685E+02	8.682E+02
IY= 9	8.712E+02	8.688E+02	8.677E+02	8.675E+02	8.676E+02
IY= 8	8.682E+02	8.672E+02	8.669E+02	8.670E+02	8.672E+02
IY= 7	8.666E+02	8.665E+02	8.665E+02	8.667E+02	8.670E+02
IY= 6	8.662E+02	8.663E+02	8.664E+02	8.666E+02	8.668E+02
IY= 5	8.667E+02	8.668E+02	8.668E+02	8.671E+02	8.672E+02
IY= 4	8.648E+02	8.648E+02	8.648E+02	8.651E+02	8.651E+02
IY= 3	8.606E+02	8.598E+02	8.591E+02	8.585E+02	8.584E+02
IY= 2	7.931E+02	7.818E+02	7.717E+02	7.620E+02	7.618E+02
IY= 1	1.725E+02	1.564E+02	1.519E+02	1.510E+02	3.734E+02
IZ=	11	12	13	14	15
IY=25	8.884E+02	8.884E+02	8.884E+02	8.884E+02	8.884E+02
IY=24	8.883E+02	8.883E+02	8.883E+02	8.883E+02	8.883E+02
IY=23	8.882E+02	8.882E+02	8.882E+02	8.882E+02	8.883E+02
IY=22	8.881E+02	8.881E+02	8.881E+02	8.881E+02	8.881E+02
IY=21	8.878E+02	8.878E+02	8.878E+02	8.879E+02	8.879E+02
IY=20	8.874E+02	8.874E+02	8.874E+02	8.875E+02	8.876E+02
IY=19	8.869E+02	8.868E+02	8.868E+02	8.869E+02	8.871E+02
IY=18	8.860E+02	8.859E+02	8.858E+02	8.860E+02	8.862E+02

IY=17	8.847E+02	8.845E+02	8.845E+02	8.846E+02	8.849E+02
IY=16	8.828E+02	8.826E+02	8.825E+02	8.826E+02	8.831E+02
IY=15	8.804E+02	8.802E+02	8.800E+02	8.801E+02	8.807E+02
IY=14	8.774E+02	8.772E+02	8.770E+02	8.770E+02	8.778E+02
IY=13	8.743E+02	8.741E+02	8.741E+02	8.740E+02	8.750E+02
IY=12	8.715E+02	8.715E+02	8.716E+02	8.716E+02	8.727E+02
IY=11	8.696E+02	8.697E+02	8.700E+02	8.700E+02	8.712E+02
IY=10	8.684E+02	8.687E+02	8.691E+02	8.692E+02	8.703E+02
IY= 9	8.678E+02	8.682E+02	8.687E+02	8.689E+02	8.700E+02
IY= 8	8.676E+02	8.680E+02	8.685E+02	8.687E+02	8.697E+02
IY= 7	8.673E+02	8.677E+02	8.683E+02	8.685E+02	8.695E+02
IY= 6	8.671E+02	8.675E+02	8.681E+02	8.686E+02	8.698E+02
IY= 5	8.675E+02	8.679E+02	8.688E+02	8.708E+02	8.734E+02
IY= 4	8.654E+02	8.658E+02	8.673E+02	8.723E+02	8.750E+02
IY= 3	8.574E+02	8.576E+02	8.594E+02	8.700E+02	8.659E+02
IY= 2	7.507E+02	7.480E+02	7.478E+02	7.702E+02	7.616E+02
IY= 1	2.878E+02	2.643E+02	2.470E+02	4.863E+02	4.447E+02

IZ=	16	17	18	19	20
IY=25	8.870E+02				
IY=24	8.759E+02				
IY=23	8.548E+02				
IY=22	8.257E+02				
IY=21	7.911E+02				
IY=20	7.530E+02				
IY=19	7.132E+02				
IY=18	6.729E+02				
IY=17	6.327E+02				
IY=16	5.927E+02				
IY=15	5.531E+02				
IY=14	5.143E+02				
IY=13	4.772E+02				
IY=12	4.434E+02				
IY=11	4.136E+02				
IY=10	3.877E+02				
IY= 9	3.652E+02				

IY= 8	3.452E+02				
IY= 7	3.271E+02				
IY= 6	3.107E+02				
IY= 5	3.023E+02				
IY= 4	3.040E+02				
IY= 3	3.097E+02				
IY= 2	2.879E+02				
IY= 1	1.642E+02				
IZ=	21				

FIELD VALUES OF WCRT

IY=25	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=24	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=23	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=22	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=21	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=20	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=19	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=18	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=17	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=16	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=15	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=14	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=13	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=12	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=11	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=10	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY= 9	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY= 8	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.883E+02
IY= 7	8.885E+02	8.885E+02	8.885E+02	8.884E+02	8.877E+02
IY= 6	8.885E+02	8.885E+02	8.885E+02	8.881E+02	8.855E+02
IY= 5	8.885E+02	8.885E+02	8.884E+02	8.876E+02	8.786E+02
IY= 4	8.885E+02	8.885E+02	8.884E+02	8.874E+02	8.729E+02
IY= 3	8.885E+02	8.885E+02	8.884E+02	8.873E+02	8.684E+02
IY= 2	8.885E+02	8.885E+02	8.884E+02	8.873E+02	8.661E+02
IY= 1	8.885E+02	8.885E+02	8.884E+02	8.873E+02	8.655E+02

IZ=	1	2	3	4	5
IY=25	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=24	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=23	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=22	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=21	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=20	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=19	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=18	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=17	8.885E+02	8.885E+02	8.885E+02	8.884E+02	8.883E+02
IY=16	8.885E+02	8.885E+02	8.885E+02	8.884E+02	8.882E+02
IY=15	8.885E+02	8.885E+02	8.884E+02	8.883E+02	8.880E+02
IY=14	8.885E+02	8.885E+02	8.884E+02	8.882E+02	8.875E+02
IY=13	8.885E+02	8.885E+02	8.883E+02	8.879E+02	8.868E+02
IY=12	8.885E+02	8.884E+02	8.881E+02	8.873E+02	8.855E+02
IY=11	8.885E+02	8.884E+02	8.877E+02	8.862E+02	8.833E+02
IY=10	8.884E+02	8.882E+02	8.869E+02	8.842E+02	8.800E+02
IY= 9	8.883E+02	8.877E+02	8.852E+02	8.808E+02	8.755E+02
IY= 8	8.878E+02	8.865E+02	8.817E+02	8.757E+02	8.705E+02
IY= 7	8.862E+02	8.831E+02	8.758E+02	8.697E+02	8.663E+02
IY= 6	8.808E+02	8.747E+02	8.681E+02	8.652E+02	8.643E+02
IY= 5	8.711E+02	8.670E+02	8.656E+02	8.649E+02	8.647E+02
IY= 4	8.653E+02	8.631E+02	8.632E+02	8.630E+02	8.628E+02
IY= 3	8.622E+02	8.613E+02	8.617E+02	8.607E+02	8.595E+02
IY= 2	8.600E+02	8.523E+02	8.433E+02	8.234E+02	8.053E+02
IY= 1	6.986E+02	5.727E+02	4.606E+02	3.120E+02	2.176E+02
IZ=	6	7	8	9	10
IY=25	8.885E+02	8.884E+02	8.884E+02	8.884E+02	8.884E+02
IY=24	8.885E+02	8.884E+02	8.884E+02	8.884E+02	8.883E+02
IY=23	8.885E+02	8.884E+02	8.884E+02	8.883E+02	8.883E+02
IY=22	8.884E+02	8.884E+02	8.883E+02	8.882E+02	8.881E+02
IY=21	8.884E+02	8.883E+02	8.882E+02	8.881E+02	8.879E+02
IY=20	8.884E+02	8.882E+02	8.880E+02	8.878E+02	8.876E+02
IY=19	8.883E+02	8.881E+02	8.877E+02	8.874E+02	8.871E+02
IY=18	8.882E+02	8.879E+02	8.872E+02	8.867E+02	8.862E+02

IY=17	8.880E+02	8.874E+02	8.864E+02	8.857E+02	8.849E+02
IY=16	8.877E+02	8.868E+02	8.852E+02	8.842E+02	8.831E+02
IY=15	8.872E+02	8.857E+02	8.835E+02	8.821E+02	8.806E+02
IY=14	8.862E+02	8.840E+02	8.811E+02	8.792E+02	8.775E+02
IY=13	8.848E+02	8.817E+02	8.780E+02	8.759E+02	8.740E+02
IY=12	8.825E+02	8.786E+02	8.745E+02	8.723E+02	8.707E+02
IY=11	8.793E+02	8.748E+02	8.711E+02	8.693E+02	8.682E+02
IY=10	8.752E+02	8.710E+02	8.682E+02	8.670E+02	8.665E+02
IY= 9	8.709E+02	8.677E+02	8.662E+02	8.657E+02	8.656E+02
IY= 8	8.671E+02	8.656E+02	8.650E+02	8.650E+02	8.652E+02
IY= 7	8.649E+02	8.645E+02	8.645E+02	8.646E+02	8.649E+02
IY= 6	8.641E+02	8.642E+02	8.642E+02	8.645E+02	8.647E+02
IY= 5	8.646E+02	8.647E+02	8.647E+02	8.650E+02	8.651E+02
IY= 4	8.627E+02	8.627E+02	8.627E+02	8.630E+02	8.630E+02
IY= 3	8.585E+02	8.577E+02	8.570E+02	8.564E+02	8.563E+02
IY= 2	7.912E+02	7.799E+02	7.698E+02	7.601E+02	7.599E+02
IY= 1	1.721E+02	1.560E+02	1.515E+02	1.506E+02	3.725E+02
IZ=	11	12	13	14	15
IY=25	8.884E+02	8.884E+02	8.884E+02	8.884E+02	8.884E+02
IY=24	8.883E+02	8.883E+02	8.883E+02	8.883E+02	8.883E+02
IY=23	8.882E+02	8.882E+02	8.882E+02	8.882E+02	8.883E+02
IY=22	8.881E+02	8.881E+02	8.881E+02	8.881E+02	8.881E+02
IY=21	8.879E+02	8.879E+02	8.879E+02	8.879E+02	8.879E+02
IY=20	8.875E+02	8.875E+02	8.875E+02	8.875E+02	8.876E+02
IY=19	8.870E+02	8.869E+02	8.869E+02	8.869E+02	8.871E+02
IY=18	8.861E+02	8.860E+02	8.860E+02	8.859E+02	8.862E+02
IY=17	8.848E+02	8.846E+02	8.845E+02	8.845E+02	8.849E+02
IY=16	8.828E+02	8.826E+02	8.825E+02	8.825E+02	8.831E+02
IY=15	8.802E+02	8.800E+02	8.798E+02	8.798E+02	8.807E+02
IY=14	8.770E+02	8.767E+02	8.765E+02	8.766E+02	8.778E+02
IY=13	8.735E+02	8.732E+02	8.731E+02	8.734E+02	8.750E+02
IY=12	8.703E+02	8.702E+02	8.703E+02	8.707E+02	8.727E+02
IY=11	8.680E+02	8.681E+02	8.683E+02	8.689E+02	8.712E+02
IY=10	8.666E+02	8.668E+02	8.672E+02	8.680E+02	8.703E+02
IY= 9	8.659E+02	8.662E+02	8.667E+02	8.675E+02	8.700E+02

IY= 8	8.655E+02	8.659E+02	8.664E+02	8.673E+02	8.697E+02
IY= 7	8.652E+02	8.656E+02	8.662E+02	8.671E+02	8.695E+02
IY= 6	8.650E+02	8.654E+02	8.660E+02	8.671E+02	8.698E+02
IY= 5	8.654E+02	8.658E+02	8.667E+02	8.692E+02	8.734E+02
IY= 4	8.632E+02	8.637E+02	8.651E+02	8.707E+02	8.750E+02
IY= 3	8.553E+02	8.555E+02	8.573E+02	8.685E+02	8.659E+02
IY= 2	7.488E+02	7.462E+02	7.460E+02	7.689E+02	7.616E+02
IY= 1	2.871E+02	2.636E+02	2.464E+02	4.855E+02	4.447E+02
IZ=	16	17	18	19	20
IY=25	8.884E+02				
IY=24	8.884E+02				
IY=23	8.884E+02				
IY=22	8.885E+02				
IY=21	8.8[illegible]5E+02				
IY=20	8.887E+02				
IY=19	8.888E+02				
IY=18	8.891E+02				
IY=17	8.894E+02				
IY=16	8.897E+02				
IY=15	8.898E+02				
IY=14	8.896E+02				
IY=13	8.889E+02				
IY=12	8.879E+02				
IY=11	8.870E+02				
IY=10	8.862E+02				
IY= 9	8.857E+02				
IY= 8	8.853E+02				
IY= 7	8.850E+02				
IY= 6	8.845E+02				
IY= 5	8.801E+02				
IY= 4	8.599E+02				
IY= 3	8.256E+02				
IY= 2	7.353E+02				
IY= 1	4.175E+02				
IZ=	21				

FIELD VALUES OF P1

IY=25	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=24	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=23	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=22	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=21	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=20	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=19	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=18	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=17	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=16	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=15	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=14	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=13	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=12	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=11	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=10	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY= 9	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY= 8	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.049E+05
IY= 7	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.050E+05
IY= 6	1.048E+05	1.048E+05	1.048E+05	1.049E+05	1.055E+05
IY= 5	1.048E+05	1.048E+05	1.048E+05	1.049E+05	1.063E+05
IY= 4	1.048E+05	1.048E+05	1.048E+05	1.049E+05	1.066E+05
IY= 3	1.048E+05	1.048E+05	1.048E+05	1.050E+05	1.067E+05
IY= 2	1.048E+05	1.048E+05	1.048E+05	1.050E+05	1.067E+05
IY= 1	1.048E+05	1.048E+05	1.048E+05	1.050E+05	1.067E+05
IZ=	1	2	3	4	5
IY=25	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=24	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=23	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=22	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=21	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=20	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=19	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=18	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.049E+05

IY=17	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.049E+05
IY=16	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.050E+05
IY=15	1.048E+05	1.048E+05	1.048E+05	1.049E+05	1.051E+05
IY=14	1.048E+05	1.048E+05	1.048E+05	1.049E+05	1.054E+05
IY=13	1.048E+05	1.048E+05	1.049E+05	1.051E+05	1.059E+05
IY=12	1.048E+05	1.048E+05	1.049E+05	1.054E+05	1.069E+05
IY=11	1.048E+05	1.049E+05	1.050E+05	1.061E+05	1.088E+05
IY=10	1.048E+05	1.049E+05	1.053E+05	1.075E+05	1.122E+05
IY= 9	1.049E+05	1.052E+05	1.061E+05	1.105E+05	1.180E+05
IY= 8	1.051E+05	1.060E+05	1.082E+05	1.164E+05	1.265E+05
IY= 7	1.060E+05	1.087E+05	1.141E+05	1.266E+05	1.360E+05
IY= 6	1.096E+05	1.179E+05	1.282E+05	1.390E+05	1.421E+05
IY= 5	1.208E+05	1.351E+05	1.408E+05	1.415E+05	1.419E+05
IY= 4	1.301E+05	1.411E+05	1.429E+05	1.417E+05	1.418E+05
IY= 3	1.375E+05	1.431E+05	1.432E+05	1.417E+05	1.417E+05
IY= 2	1.414E+05	1.434E+05	1.432E+05	1.417E+05	1.417E+05
IY= 1	1.424E+05	1.432E+05	1.430E+05	1.416E+05	1.416E+05
IZ=	6	7	8	9	10
IY=25	1.048E+05	1.048E+05	1.048E+05	1.049E+05	1.049E+05
IY=24	1.048E+05	1.048E+05	1.049E+05	1.049E+05	1.050E+05
IY=23	1.048E+05	1.048E+05	1.049E+05	1.050E+05	1.051E+05
IY=22	1.048E+05	1.049E+05	1.049E+05	1.051E+05	1.052E+05
IY=21	1.048E+05	1.049E+05	1.050E+05	1.053E+05	1.055E+05
IY=20	1.049E+05	1.049E+05	1.052E+05	1.056E+05	1.059E+05
IY=19	1.049E+05	1.050E+05	1.054E+05	1.061E+05	1.066E+05
IY=18	1.050E+05	1.052E+05	1.059E+05	1.070E+05	1.077E+05
IY=17	1.051E+05	1.056E+05	1.066E+05	1.083E+05	1.095E+05
IY=16	1.053E+05	1.061E+05	1.077E+05	1.103E+05	1.120E+05
IY=15	1.057E+05	1.071E+05	1.096E+05	1.133E+05	1.156E+05
IY=14	1.064E+05	1.087E+05	1.124E+05	1.174E+05	1.203E+05
IY=13	1.078E+05	1.112E+05	1.164E+05	1.225E+05	1.259E+05
IY=12	1.100E+05	1.151E+05	1.217E+05	1.283E+05	1.315E+05
IY=11	1.137E+05	1.206E+05	1.278E+05	1.338E+05	1.362E+05
IY=10	1.193E+05	1.273E+05	1.340E+05	1.381E+05	1.396E+05
IY= 9	1.268E+05	1.342E+05	1.387E+05	1.408E+05	1.413E+05

IY= 8	1.347E+05	1.395E+05	1.414E+05	1.420E+05	1.419E+05
IY= 7	1.405E+05	1.420E+05	1.423E+05	1.422E+05	1.420E+05
IY= 6	1.424E+05	1.423E+05	1.423E+05	1.422E+05	1.419E+05
IY= 5	1.423E+05	1.424E+05	1.423E+05	1.422E+05	1.418E+05
IY= 4	1.422E+05	1.424E+05	1.423E+05	1.422E+05	1.417E+05
IY= 3	1.422E+05	1.424E+05	1.423E+05	1.422E+05	1.416E+05
IY= 2	1.422E+05	1.424E+05	1.423E+05	1.422E+05	1.415E+05
IY= 1	1.421E+05	1.424E+05	1.423E+05	1.422E+05	1.417E+05
IZ=	11	12	13	14	15
IY=25	1.050E+05	1.050E+05	1.050E+05	1.050E+05	1.050E+05
IY=24	1.050E+05	1.050E+05	1.050E+05	1.050E+05	1.050E+05
IY=23	1.051E+05	1.052E+05	1.052E+05	1.052E+05	1.052E+05
IY=22	1.053E+05	1.054E+05	1.054E+05	1.054E+05	1.054E+05
IY=21	1.057E+05	1.057E+05	1.058E+05	1.058E+05	1.058E+05
IY=20	1.063E+05	1.063E+05	1.064E+05	1.064E+05	1.065E+05
IY=19	1.072E+05	1.073E+05	1.074E+05	1.075E+05	1.075E+05
IY=18	1.086E+05	1.088E+05	1.090E+05	1.091E+05	1.092E+05
IY=17	1.108E+05	1.111E+05	1.113E+05	1.115E+05	1.117E+05
IY=16	1.139E+05	1.143E+05	1.147E+05	1.150E+05	1.152E+05
IY=15	1.181E+05	1.187E+05	1.192E+05	1.195E+05	1.197E+05
IY=14	1.233E+05	1.240E+05	1.245E+05	1.249E+05	1.250E+05
IY=13	1.289E+05	1.295E+05	1.300E+05	1.302E+05	1.300E+05
IY=12	1.340E+05	1.344E+05	1.347E+05	1.346E+05	1.341E+05
IY=11	1.379E+05	1.381E+05	1.380E+05	1.377E+05	1.368E+05
IY=10	1.403E+05	1.402E+05	1.399E+05	1.393E+05	1.382E+05
IY= 9	1.414E+05	1.411E+05	1.406E+05	1.399E+05	1.386E+05
IY= 8	1.417E+05	1.413E+05	1.407E+05	1.399E+05	1.387E+05
IY= 7	1.417E+05	1.412E+05	1.407E+05	1.399E+05	1.386E+05
IY= 6	1.416E+05	1.412E+05	1.407E+05	1.398E+05	1.382E+05
IY= 5	1.417E+05	1.414E+05	1.408E+05	1.393E+05	1.347E+05
IY= 4	1.418E+05	1.415E+05	1.408E+05	1.383E+05	1.278E+05
IY= 3	1.419E+05	1.416E+05	1.408E+05	1.371E+05	1.159E+05
IY= 2	1.420E+05	1.416E+05	1.408E+05	1.365E+05	1.063E+05
IY= 1	1.419E+05	1.415E+05	1.407E+05	1.374E+05	1.042E+05
IZ=	16	17	18	19	20

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 IY=25   1.050E+05   1.049E+05
 IY=24   1.050E+05   1.049E+05
 IY=23   1.051E+05   1.049E+05
 IY=22   1.054E+05   1.049E+05
 IY=21   1.057E+05   1.049E+05
 IY=20   1.063E+05   1.049E+05
 IY=19   1.073E+05   1.049E+05
 IY=18   1.088E+05   1.049E+05
 IY=17   1.111E+05   1.049E+05
 IY=16   1.142E+05   1.049E+05
 IY=15   1.183E+05   1.049E+05
 IY=14   1.229E+05   1.049E+05
 IY=13   1.272E+05   1.049E+05
 IY=12   1.307E+05   1.049E+05
 IY=11   1.330E+05   1.049E+05
 IY=10   1.341E+05   1.049E+05
 IY= 9   1.345E+05   1.049E+05
 IY= 8   1.345E+05   1.049E+05
 IY= 7   1.344E+05   1.049E+05
 IY= 6   1.337E+05   1.049E+05
 IY= 5   1.275E+05   1.049E+05
 IY= 4   1.185E+05   1.049E+05
 IY= 3   1.088E+05   1.047E+05
 IY= 2   1.061E+05   1.026E+05
 IY= 1   1.060E+05   8.849E+04
 IZ=     21          22
FIELD VALUES OF  PP (density)
 IY=25   1.835E+00   1.835E+00   1.835E+00   1.835E+00   1.835E+00
 IY=24   1.835E+00   1.835E+00   1.835E+00   1.835E+00   1.835E+00
 IY=23   1.835E+00   1.835E+00   1.835E+00   1.835E+00   1.835E+00
 IY=22   1.835E+00   1.835E+00   1.835E+00   1.835E+00   1.835E+00
 IY=21   1.835E+00   1.835E+00   1.835E+00   1.835E+00   1.835E+00
 IY=20   1.835E+00   1.835E+00   1.835E+00   1.835E+00   1.835E+00
 IY=19   1.835E+00   1.835E+00   1.835E+00   1.835E+00   1.835E+00
 IY=18   1.835E+00   1.835E+00   1.835E+00   1.835E+00   1.835E+00
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IY=17	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=16	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=15	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=14	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=13	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=12	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=11	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=10	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY= 9	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.836E+00
IY= 8	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.836E+00
IY= 7	1.835E+00	1.835E+00	1.835E+00	1.836E+00	1.838E+00
IY= 6	1.835E+00	1.835E+00	1.835E+00	1.836E+00	1.844E+00
IY= 5	1.835E+00	1.835E+00	1.835E+00	1.837E+00	1.855E+00
IY= 4	1.835E+00	1.835E+00	1.835E+00	1.837E+00	1.859E+00
IY= 3	1.835E+00	1.835E+00	1.835E+00	1.837E+00	1.860E+00
IY= 2	1.835E+00	1.835E+00	1.835E+00	1.837E+00	1.860E+00
IY= 1	1.835E+00	1.835E+00	1.835E+00	1.837E+00	1.860E+00
IZ=	1	2	3	4	5
IY=25	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=24	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=23	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=22	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=21	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=20	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.836E+00
IY=19	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.836E+00
IY=18	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.836E+00
IY=17	1.835E+00	1.835E+00	1.835E+00	1.836E+00	1.836E+00
IY=16	1.835E+00	1.835E+00	1.835E+00	1.836E+00	1.837E+00
IY=15	1.835E+00	1.835E+00	1.835E+00	1.836E+00	1.839E+00
IY=14	1.835E+00	1.835E+00	1.836E+00	1.837E+00	1.843E+00
IY=13	1.835E+00	1.835E+00	1.836E+00	1.839E+00	1.849E+00
IY=12	1.835E+00	1.836E+00	1.836E+00	1.843E+00	1.862E+00
IY=11	1.835E+00	1.836E+00	1.838E+00	1.852E+00	1.887E+00
IY=10	1.836E+00	1.837E+00	1.842E+00	1.870E+00	1.931E+00
IY= 9	1.837E+00	1.840E+00	1.852E+00	1.908E+00	2.004E+00

IY= 8	1.840E+00	1.850E+00	1.879E+00	1.983E+00	2.109E+00
IY= 7	1.851E+00	1.886E+00	1.954E+00	2.110E+00	2.226E+00
IY= 6	1.897E+00	2.003E+00	2.131E+00	2.263E+00	2.300E+00
IY= 5	2.039E+00	2.215E+00	2.284E+00	2.292E+00	2.297E+00
IY= 4	2.154E+00	2.288E+00	2.308E+00	2.295E+00	2.295E+00
IY= 3	2.244E+00	2.312E+00	2.312E+00	2.295E+00	2.295E+00
IY= 2	2.291E+00	2.315E+00	2.312E+00	2.295E+00	2.295E+00
IY= 1	2.303E+00	2.313E+00	2.310E+00	2.293E+00	2.294E+00
IZ=	6	7	8	9	10
IY=25	1.835E+00	1.836E+00	1.836E+00	1.837E+00	1.837E+00
IY=24	1.835E+00	1.836E+00	1.836E+00	1.837E+00	1.837E+00
IY=23	1.835E+00	1.836E+00	1.836E+00	1.838E+00	1.839E+00
IY=22	1.836E+00	1.836E+00	1.837E+00	1.839E+00	1.840E+00
IY=21	1.836E+00	1.836E+00	1.838E+00	1.841E+00	1.844E+00
IY=20	1.836E+00	1.837E+00	1.840E+00	1.846E+00	1.849E+00
IY=19	1.836E+00	1.838E+00	1.843E+00	1.852E+00	1.859E+00
IY=18	1.837E+00	1.841E+00	1.849E+00	1.863E+00	1.873E+00
IY=17	1.839E+00	1.845E+00	1.858E+00	1.880E+00	1.895E+00
IY=16	1.842E+00	1.852E+00	1.873E+00	1.906E+00	1.928E+00
IY=15	1.847E+00	1.865E+00	1.897E+00	1.944E+00	1.974E+00
IY=14	1.856E+00	1.885E+00	1.933E+00	1.996E+00	2.033E+00
IY=13	1.873E+00	1.918E+00	1.984E+00	2.060E+00	2.102E+00
IY=12	1.903E+00	1.967E+00	2.050E+00	2.132E+00	2.171E+00
IY=11	1.950E+00	2.036E+00	2.126E+00	2.199E+00	2.229E+00
IY=10	2.021E+00	2.119E+00	2.201E+00	2.252E+00	2.269E+00
IY= 9	2.113E+00	2.204E+00	2.259E+00	2.284E+00	2.290E+00
IY= 8	2.210E+00	2.268E+00	2.291E+00	2.298E+00	2.297E+00
IY= 7	2.281E+00	2.298E+00	2.301E+00	2.300E+00	2.298E+00
IY= 6	2.303E+00	2.302E+00	2.302E+00	2.300E+00	2.297E+00
IY= 5	2.302E+00	2.303E+00	2.302E+00	2.300E+00	2.296E+00
IY= 4	2.301E+00	2.303E+00	2.302E+00	2.301E+00	2.294E+00
IY= 3	2.301E+00	2.303E+00	2.302E+00	2.301E+00	2.293E+00
IY= 2	2.300E+00	2.303E+00	2.302E+00	2.300E+00	2.292E+00
IY= 1	2.300E+00	2.303E+00	2.302E+00	2.300E+00	2.295E+00
IZ=	11	12	13	14	15

IY=25	1.838E+00	1.838E+00	1.838E+00	1.838E+00	1.838E+00
IY=24	1.838E+00	1.838E+00	1.838E+00	1.838E+00	1.838E+00
IY=23	1.840E+00	1.840E+00	1.840E+00	1.840E+00	1.840E+00
IY=22	1.842E+00	1.843E+00	1.843E+00	1.843E+00	1.843E+00
IY=21	1.847E+00	1.847E+00	1.848E+00	1.848E+00	1.848E+00
IY=20	1.854E+00	1.855E+00	1.856E+00	1.856E+00	1.857E+00
IY=19	1.866E+00	1.868E+00	1.869E+00	1.870E+00	1.871E+00
IY=18	1.884E+00	1.887E+00	1.889E+00	1.891E+00	1.892E+00
IY=17	1.912E+00	1.916E+00	1.919E+00	1.922E+00	1.924E+00
IY=16	1.952E+00	1.957E+00	1.962E+00	1.966E+00	1.968E+00
IY=15	2.005E+00	2.012E+00	2.018E+00	2.023E+00	2.025E+00
IY=14	2.070E+00	2.078E+00	2.085E+00	2.090E+00	2.091E+00
IY=13	2.140E+00	2.147E+00	2.153E+00	2.155E+00	2.153E+00
IY=12	2.202E+00	2.207E+00	2.210E+00	2.209E+00	2.203E+00
IY=11	2.249E+00	2.251E+00	2.250E+00	2.246E+00	2.236E+00
IY=10	2.278E+00	2.277E+00	2.273E+00	2.266E+00	2.253E+00
IY= 9	2.291E+00	2.287E+00	2.281E+00	2.273E+00	2.258E+00
IY= 8	2.294E+00	2.290E+00	2.283E+00	2.274E+00	2.258E+00
IY= 7	2.294E+00	2.289E+00	2.282E+00	2.273E+00	2.257E+00
IY= 6	2.294E+00	2.289E+00	2.282E+00	2.272E+00	2.253E+00
IY= 5	2.295E+00	2.291E+00	2.284E+00	2.266E+00	2.211E+00
IY= 4	2.296E+00	2.292E+00	2.284E+00	2.254E+00	2.125E+00
IY= 3	2.298E+00	2.294E+00	2.284E+00	2.239E+00	1.977E+00
IY= 2	2.298E+00	2.294E+00	2.284E+00	2.233E+00	1.854E+00
IY= 1	2.297E+00	2.292E+00	2.282E+00	2.242E+00	1.827E+00

IZ=	16	17	18	19	20
IY=25	1.838E+00	1.837E+00			
IY=24	1.838E+00	1.837E+00			
IY=23	1.840E+00	1.837E+00			
IY=22	1.842E+00	1.837E+00			
IY=21	1.847E+00	1.837E+00			
IY=20	1.855E+00	1.837E+00			
IY=19	1.868E+00	1.837E+00			
IY=18	1.887E+00	1.837E+00			
IY=17	1.916E+00	1.837E+00			

```
 IY=16   1.956E+00   1.837E+00
 IY=15   2.007E+00   1.837E+00
 IY=14   2.065E+00   1.837E+00
 IY=13   2.119E+00   1.837E+00
 IY=12   2.161E+00   1.837E+00
 IY=11   2.189E+00   1.837E+00
 IY=10   2.203E+00   1.837E+00
 IY= 9   2.207E+00   1.837E+00
 IY= 8   2.208E+00   1.837E+00
 IY= 7   2.207E+00   1.837E+00
 IY= 6   2.198E+00   1.837E+00
 IY= 5   2.122E+00   1.837E+00
 IY= 4   2.010E+00   1.837E+00
 IY= 3   1.886E+00   1.834E+00
 IY= 2   1.852E+00   1.806E+00
 IY= 1   1.851E+00   1.619E+00
 IZ=     21          22

**********************************************************************
USER:- NAME OF FILE CONTAINING FINAL FLOW FIELDS IS TM1
        LAST SWEEP =   100
        LAST STEP  =     1
**********************************
```

APPENDIX E

PROGRAM CALCULATES LAMINAR DISTRIBUTION QUANTITIES

```
C     THIS PROGRAM CALCULATES CF,ST,Q,H OVER THE VANE FOR
C     LAMINAR FLOW
      REAL*8 Y1(20),Y2(20),H(20),W(20),ST(20),Q(20),CF(20),RA(20)
      REAL*8 BZFRAC(20),EMU,GPGP,PR,HW,HCON(20),RO(20)
      REAL*8 REZ(20),CFB(20),Z(20),TAW(20),Y0(20),D1(20),D2(20)
      REAL*8 P(20),PK(20),CW(20),ZO(20),V(20),TMP(20),VISC(20)
      INTEGER IZ
      GH=6.4E-03
      GD=10*GH
      GL=95.2E-03
      GTL=1.24*GL
      GBETA=4.
      GBETA=GBETA*3.1415927/180
      GTAB=TAN(GBETA)
      DELMAX=2.E-03
      GNBL=5.
      GPWR=3.
      EMU=0.8E-05
      ROE=1.835
      PE=1.048E+05
      WE=888.5
      RUU=0.5*ROE*WE**2
C     RUU=ROE*WE**2
      GAMA=1.35
      RW=287.
      CP=GAMA*RW/(GAMA-1.)
      HW=323.*CP
      HO=555.5*CP
      PR=0.7
      GPCP=EMU/PR
```

```
      DO 10 IZ=1,6
      Y1(IZ)=(1./5.)**GPWR*DELMAX
      Y2(IZ)=(2./5.)**GPWR*DELMAX
   10 CONTINUE
      BZFRAC(1)=42.373E-3
      DO 66 IZ=2,8
   66 BZFRAC(IZ)=42.373E-3+BZFRAC(IZ-1)
      DO 67 IZ=9,14
   67 BZFRAC(IZ)=84.75E-3+BZFRAC(IZ-1)
      DO 68 IZ=15,16
   68 BZFRAC(IZ)=42.73E-3+BZFRAC(IZ-1)
      DO 69 IZ=17,20
   69 BZFRAC(IZ)=11.295E-3+BZFRAC(IZ-1)
      DO 20 IZ=6,20
      Y1(IZ)=Y1(1)*(GD-(BZFRAC(IZ)-BZFRAC(5))*GTAB*GTL)/GD
      Y2(IZ)=Y2(1)*(GD-(BZFRAC(IZ)-BZFRAC(5))*GTAB*GTL)/GD
      Z(IZ)=(BZFRAC(IZ)-BZFRAC(5))*GTL
      READ(5,12) H(IZ),W(IZ),RO(IZ),P(IZ),V(IZ)
      TMP(IZ)=(H(IZ)-W(IZ)**2/2.-V(IZ)**2/2.)/CP
      IF(TMP(IZ).LT.150.) TMP(IZ)=150
      VISC(IZ)=1.716E-05*(TMP(IZ)/273.)**0.666
      IF(VISC(IZ).LE..8E-05) VISC(IZ)=.8E-05
      TAW(IZ)=2*VISC(IZ)*W(IZ)/(Y1(IZ))
      CF(IZ)=TAW(IZ)/RUU
      CW(IZ)=(RO(IZ)/ROE)*(VISC(IZ)/EMU)
      PK(IZ)=P(IZ)/PE
      REZ(IZ)=RO(IZ)*WE*Z(IZ)/VISC(IZ)
C     CFB(IZ)=0.664/SQRT(REZ(IZ))
      ZO(IZ)=SQRT(PK(IZ)*CW(IZ)/REZ(IZ))
      CFB(IZ)=0.664*ZO(IZ)
      Q(IZ)=(EMU/PR)**2*(H(IZ)-HW)/(Y1(IZ))
      ST(IZ)=Q(IZ)/(ROE*WE*(0.9*HO-HW))
      HCON(IZ)=ROE*WE*CP*ST(IZ)
      RA(IZ)=ST(IZ)/(CF(IZ)*PR**(-2./3.))
C     WRITE(6,19) Z(IZ),CP(IZ)
```

```
C       WRITE(8,27) Z(IZ),ST(IZ)
C       WRITE(8,21) Z(IZ),Q(IZ)
        WRITE(8,22) Z(IZ),HCON(IZ)
C       WRITE(8,23) Z(IZ),RA(IZ)
C       WRITE(8,24) Z(IZ),CFB(IZ)
C       WRITE(8,28) REZ(IZ),CFB(IZ)
   20   CONTINUE
   12   FORMAT(3X,E10.3,3X,E10.3,3X,E10.3,3X,E10.3,3X,E10.3)
C  19   FORMAT(3X,E10.3,3X,E10.3)
C  27   FORMAT(3X,E10.3,3X,E10.3)
C  21   FORMAT(3X,E10.3,3X,E10.3)
   22   FORMAT(3X,E10.3,3X,E10.3)
C  23   FORMAT(3X,E10.3,3X,E10.3)
C  24   FORMAT(3X,E10.3,3X,E10.3)
C  28   FORMAT(3X,E12.5,3X,E12.5)
        STOP
        END
```

APPENDIX E

SATELITE PROGRAM OF PHOENICS USED IN TURBULENT FLOW ANALYSIS

```
C$DIRECTIVE**SATLIT
C      NZ=22 NY=25 YN=10*GH
C     *FILE NAME: MODBFCST.FTN
C     *ABSTRACT: SATELLITE MODEL MAIN PROGRAM. THIS VERSION IS
C      FOR USE WITH THE BODY-FITTED COORDINATE SCHEME (SUMMER 1984
C      VERSION) PROVIDED AS AN ATTACHMENT TO SPRING 1983 PHOENICS.
C     *DOCUMENTATION: PHOENICS INSTRUCTION MANUAL (SPRING 1983)
C      WITH BODY-FITTED COORDINATES INSTRUCTION SUPPLEMENT
C      (SUMMER 1984).
C     *AUXILIARY SUBROUTINES (TAPES, ETC.) ARE IN SATELLITE LIBRARY
C      SERVICEU, WHICH MUST BE INCLUDED IN LINK EDIT TO RUN.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 1 STARTS:
C-------------------------------------------------------------------
CHAPTER 1   COMMON BLOCKS AND USER'S DATA.
C-------------------------------------------------------------------
      INCLUDE (CMNGUS)
       INCLUDE (CMNGRF)
      INCLUDE (GUSSEQ)
      COMMON/CPI/IPWRIT,IDUM(243)
      DIMENSION GDTAPE(3),DFAULT(4)
      DIMENSION ARRAY1(309),ARRAY2(194),ARRAY3(421)
      LOGICAL ARRAY1,LSPDA,WRT,RD,NAMLST
      INTEGER ARRAY2,XPLANE,YPLANE,ZPLANE
      INTEGER P1,PP,U1,U2,V1,V2,W1,W2,R1,R2,RS,EP,H1,H2,H3,C1,C2,
     &C3,C4
      REAL NORTH,LOW
      LOGICAL BFC
      EQUIVALENCE (ARRAY1(1),CARTES),(ARRAY2(1),NX)
      EQUIVALENCE (ARRAY3(1),SPARE1(1)),(M1,R1),(M2,R2)
      EQUIVALENCE (LSTRUN,INTGR(12)),(NAMLST,LOGIC(88))
```

```
      EQUIVALENCE (LOGIC(20),BFC)
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 1 ENDS.
C$DIRECTIVE**CMNBF1$$
C  THIS FILE CONTAINS SATELLITE COMMON BLOCKS FOR BFC'S
C  F1 MUST BE DIMENSIONED TO GREATER THAN OR EQUAL TO
C (NX+NY+17*NZ+24*NX*NY+6*(NX+1)*(NY+1)+6*ND). THE VALUE
C  OF THE DIMENSION MUST BE SET AS NBFC IN GROUP 6 OF SATLIT.
      COMMON/FOB/F1(5000)
      COMMON/CIB/ND/CIC/KOORD
      COMMON/CID/KDBGG,KDBGMF,KDBGCD,KDBIND,KDBMFX,KDBCDT,KDBPCS,
     &           KDBGUV,KDBGPV
      COMMON/CIE/KDBGS,KDBINS
      COMMON/CIF/IGEN/CIG/NCART
C  THE FOLLOWING ARRAYS MUST BE EXACTLY DIMENSIONED FOR NXP1,
C  NYP1 AND NZP1, BUT MAY BE OVER DIMENSIONED FOR ND.
C  THE BFRAC ARRAYS MUST BE DIMENSIONED TO ALLOW FOR SETTINGS
C  IN SATLIT, THEY MAY BE OVER DIMENSIONED.
      COMMON/CRA/XW(26,23,1)/CRB/XE(26,23,1)
     &      /CRC/YS(2,23,1)/CRD/YN(2,23,1)
     &      /CRE/ZL(2,26,1)/CRF/ZH(2,26,1)
     &      /CRG/RCON/CRH/DARCY/CRI/BXFRAC(99)/CRJ/BYFRAC(99)
     &      /CRK/BZFRAC(99)
      COMMON/CLA/STORSA(6),STORWD(6),STORP,STORPE,STORPN,
     &           STORPH,STOR1,STOR2,STOR3,STOUNV,PRTBFC,STOCRN
      COMMON/CLC/BFPLOT
      LOGICAL STORP,STORPE,STORPN,STORPH,STOR1,STOR2,STOR3,
     &        STORSA,STORWD,STOUNV,PRTBFC,BFPLOT,STOCRN
C     END
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 1 STARTS:
C     GRAFFIC ARRAYS DIMENSIONED AS NEEDED...
      COMMON/GRAF1/PHI1(1) /GRAF2/PHI2(1)
C     POROSITY & SPECIAL DATA ARRAYS DIMENSIONED AS NEEDED...
      DIMENSION PE(1,1,1),PN(1,1,1),PH(1,1,1),PC(1,1,1)
      DIMENSION LSPDA(1),ISPDA(1),RSPDA(1)
C     USER PLACES HIS VARIABLES, ARRAYS, EQUIVALENCES ETC. HERE.
```

```
      EQUIVALENCE(RAIR,RE(21)),(GAMA,RE(22)),(GSWP,RE(23))
C     USER PLACES HIS DATA STATEMENTS HERE.
      DATA NLSP,NISP,NRSP/1,1,1/
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 1 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 2 STARTS:
C-------------------------------------------------------------
CHAPTER 2   SET CONSTANTS, AND ARRANGE FILE MANIPULATIONS.
C-------------------------------------------------------------
C     PLEASE DO NOT ALTER, OR RE-SET, ANY OF THE REMAINING
C     STATEMENTS OF THIS CHAPTER.
      DATA CELL,EAST,WEST,NORTH,SOUTH,HIGH,LOW,VOLUME/
     & 0.,1.,2.,3.,4.,5.,6.,7. /
      DATA P1,PP,U1,U2,V1,V2,W1,W2,R1,R2,RS,KE,EP,H1,H2,H3,C1,C2,
     &C3,C4/1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20/
      DATA FIXFLU,FIXVAL,ONLYMS,WALL/1.E-10,1.E10,0.0,-10.0/
      DATA IPLANE,XPLANE,YPLANE,ZPLANE/0,1,2,3/
      DATA WRT,RD,DEFAULT/.TRUE.,.FALSE.,4HDEFA,4HULT.,4HDTA/,1HG/
      DATA GDTAPE/4HGUSI,4HE1.D,2HTA/
      DATA NLDATA,NIDATA,NRDATA/309,194,421/
      DATA NLCREG,NTCVRG/60,350/
      DATA TITPP,TITC1,TITC2/3HRHO,4HMACH,4HTEMP/
      CALL TAPES(10,GDTAPE,3,1,4*NRDATA)
C-----------------------------READ DEFAULT FILE IF BLOCKDATA ABSENT
          IF(INTGR1(29).NE.10) GO TO 2
      CALL WRIT40(40HDATA ESTABLISHED IN BLOCK DATA.          )
      GO TO 3
    2 CALL DEFLT
CD  2 CALL TAPES(1,DFAULT,4,2,4*NRDATA)
CD    CALL DATAIO(RD,1)
      CALL WRIT40(40HDATA TAKEN FROM DEFAULT.DTA ON GROUP A/C)
    3 CALL WRIT40(40HFILE MODSTL.FTN IS THE SATLIT USED.      )
      LOGIC(89)=.TRUE.
C-------------------------------------------------------------
CHAPTER 3   DEFINE DATA FOR NRUN RUNS.
C-------------------------------------------------------------
```

```
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 2 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 2 STARTS:
C--- GROUP  41 MULTI-RUNS : RUN(1-30)<.T.,29*.F.>
C
      RUN(1)=.FALSE.
C  NOTE: ALL RUNS ARE DEACTIVATED AT THIS POINT - USER SHOULD
C  ====  SWITCH ON ONE ONLY OF RUNS 1-4 IN NEXT STATEMENT.
      RUN(1)=.TRUE.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 2 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 3 STARTS:
        DO 10 IRUN=1,30
          IF(.NOT.RUN(IRUN)) GO TO 10
      NRUN=NRUN+1
      LSTRUN=IRUN
   10 CONTINUE
        DO 999 IRUN=1,LSTRUN
          IF(.NOT.RUN(IRUN)) GO TO 999
      INTGR(11) = IRUN
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 3 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 3 STARTS:
C---  ALL INTEGER VARIABLES ARE DEFAULTED TO 0, AND REAL VARIABLES
C     TO 0.0, UNLESS OTHERWISE INDICATED.
C     E.G. BY VARIABLE<10>, OR <10.0> AS APPROPRIATE.
C     THE DEFAULT SETTINGS OF ALL LOGICAL VARIABLES ARE ALWAYS
C     INDICATED, E.G. VARIABLE<.T.>, OR  VARIABLE<.F.>.
C
C---  RUN1
C------------------    --------------    ------------------
C---  GROUP 1. FLOW TYPE :
C     PARAB<.F.>,CARTES<.T.>,ONEPHS<.T.>
C------------------    --------------    ------------------
C---  GROUP 2. TRANSIENCE :
C     STEADY<.T.>,ATIME,LSTEP<1>,FSTEP<1>
C     TLAST<1.E10>,TFRAC(1-30)<30*1.>
C     SERVICE SUBROUTINE FOR 'NT' POWER-LAW TIME STEPS:
```

```
C     CALL GRDPWR(0,NT,TLAST,POWER)
C------------------    --------------    ------------------
C---  GROUP 3. X-DIRECTION :
C     NX<1>,XULAST<1.0>,XFRAC(1-30)
C     SERVICE SUBROUTINE FOR POWER-LAW GRID:
C     CALL GRDPWR(1,NX,XULAST,POWER)
C------------------    --------------    ------------------
C---  GROUP 4. Y-DIRECTION :
C     NY<1>,YVLAST<1.0>,YFRAC(1-30),RINNER,SNALFA
C     SERVICE SUBROUTINE FOR POWER-LAW GRID:
C     CALL GRDPWR(2,NY,YVLAST,POWER)
      NY=25
C------------------    --------------    ------------------
C---  GROUP 5. Z-DIRECTION :
C     NZ<1>,ZWLAST<1.0>,ZFRAC(1-30)
C     SERVICE SUBROUTINE FOR POWER-LAW GRID:
C     CALL GRDPWR(3,NZ,ZWLAST,POWER)
      NZ=22
C------------------    --------------    ------------------
C---  GROUP 6. MOVING GRID OR DISTORTED (BODY-FITTED) GRID :
C              --- MOVING GRID :
C     MGRID,IZW1,IZW2,AZW2,BZW2,CZW2,PINT,ZW2M1T
C-----------------------------------------------------------------
C              --- BODY-FITTED GRID ---
C     BFC<.T.>,IGEN<1>,ND<1>,NBFC<5000>,KOORD,RCON
C     BXFRAC(1-NX)<1.0,NXM1*0.0>
C     BYFRAC(1-NY)<1.0,NYM1*0.0>
C     BZFRAC(1-NZ)<1.0,NZM1*0.0>
C     SERVICE SUBROUTINE FOR SUB-DOMAIN SPECIFICATION (FOR IGEN=1
C     ONLY):
C       CALL DOMAIN(ID,IXF,IXL,IYF,IYL,IZF,IZL)
C     XE(1-NYP1,1-NZP1,1-ND)<(NYP1*NZP1*ND)*1.0>,
C     XW(1-NYP1,1-NZP1,1-ND),
C     YN(1-NXP1,1-NZP1,1-ND)<(NXP1*NZP1*ND)*1.0>,
C     YS(1-NXP1,1-NZP1,1-ND),
```

```
C     ZH(1-NXP1,1-NYP1,1-ND)<(NXP1*NYP1*ND)*1.0>,
C     ZL(1-NXP1,1-NYP1,1-ND),STORSA(1-6)<6*.F.>,STORWD(1-6)<6*.F.>,
C     STORP<.F.>,STORPE<.F.>,STORPN<.F.>,STORPH<.F.>,STOUNV<.F.>,
C     PRTBFC<.F.>,DARCY,BFPLOT<.F.>
C     CYCLIC BOUNDARY CONDITIONS ARE DEFAULTED INACTIVE ;
C     TO ACTIVATE THEM AT SELECTED IZ SLABS USE SERVICE SUBROUTINE:
C        CALL XCYIZ(IZ,.TRUE.)
C     SERVICE SUBROUTINE TO DEACTIVATE CURVATURE TERMS IN U, V
C     AND W EQUATIONS ASSOCIATED WITH CURVATURE OF IX, IY, IZ
C     GRID LINES RESPECTIVELY:
C        CALL UCURVE(IZ,.FALSE.)
C        CALL VCURVE(IZ,.FALSE.)
C        CALL WCURVE(IZ,.FALSE.)
C     NCART<1>
C    *WARNINGS||||||
C     ------------
C       A) WHEN USING BFCS STOVAR(H3), STOVAR(C4), STOVAR(21) ARE
C          AVAILABLE ONLY FOR STORING NON-ORTHOGONAL VELOCITY
C          COMPONENTS.
C       B) MULTI-RUNS ARE NOT ALLOWED WITH BFC OPTION.
C       C) MOVING GRID,TWO-PHASE AND PARABOLIC OPTIONS ARE NOT
C          AVAILABLE WITH BFC OPTION.
C       D) KE-EP TURBULENCE MODEL SHOULD BE USED WITH BFC'S ONLY
C          WHEN THE MAIN FLOW IS IN THE IZ DIRECTION.
C       E) BUILT-IN GRAVITY TERMS DO NOT TAKE ACCOUNT OF BFC'S.
C    *NOTES
C     -----
C       A) THE STANDARD VELOCITY-FIELD PRINTOUT FOR THE
C          VELOCITY RESOLUTES IS ACTIVATED IN THE USUAL
C          WAY. AN ADDITIONAL OPTION EXISTS FOR PRINTING THE
C          CARTESIAN VELOCITY-COMPONENTS WHICH MAY BE
C          ACTIVATED BY SETTING THE FOLLOWING LOGICALS:
C               STOVAR(U2)=.T. FOR U-COMPONENT (CARTESIAN)
C               STOVAR(V2)=.T. FOR V-COMPONENT (CARTESIAN)
C               STOVAR(W2)=.T. FOR W-COMPONENT (CARTESIAN)
```

```
C          SIMILARLY PRINTOUT OF NON-ORTHOGONAL VELOCITY
C          COMPONENTS MAY BE ACTIVATED AS FOLLOWS:
C               STOVAR(C4)=.T. FOR U-COMPONENT (NON-ORTHOG)
C               STOVAR(H3)=.T. FOR V-COMPONENT (NON-ORTHOG)
C               STOVAR(21)=.T. FOR W-COMPONENT (NON-ORTHOG)
C       B) BFC (TO ACTIVATE THE BFC OPTION), IGEN (THE CODE FOR METHOD
C          OF GRID SPECIFICATION), ND (NUMBER OF SUB-DOMAINS) AND
C          NBFC (THE F1 ARRAY DIMENSION), MUST BE SET BEFORE
C          "STANDARD BFC SECTION 2".                    ======
C          ALL OTHER BFC DATA MUST BE SET AFTER "STANDARD BFC
C          SECTION 2.                          =====
C       C) NXP1, NYP1, NZP1 STORE NX+1, NY+1, NZ+1; THESE ARE
C          AVAILABLE TO USER AFTER STANDARD BFC SECTION 2.
C       D) FOR IGEN=1 USE BXFRAC,BYFRAC & BZFRAC IN PLACE OF
C          XFRAC,YFRAC & ZFRAC.
C-----------------------------------------------------------------
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD BFC SECTION 1 STARTS:
C     DEFAULT SETTINGS:
      NCART=10
      BFC=.TRUE.
      IGEN=1
      ND=1
      NBFC=5000
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD BFC SECTION 1 ENDS.:
C    *USER SETS BFC, IGEN, ND AND NBFC HERE:
C
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD BFC SECTION 2 STARTS:
      CALL SB4I(NXP1,NX+1,NYP1,NY+1,NZP1,NZ+1,I,0)
      IF(BFC) CALL BFCDFT(NBFC,XE,XW,YN,YS,ZH,ZL,ND,NXP1,NYP1,
     &                    NZP1,NZ)
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD BFC SECTION 2 ENDS.
C    *USER SETS ALL OTHER BFC VARIABLES HERE:
C    *USING NONIFORM GRID 1-8
      GH=6.4E-3
      GL=95.2E-3
```

```
      GTL=1.24*GL
      GBETA=4.
      GBETA=GBETA*3.1415927/180
      GTAB=TAN(GBETA)
      DELMAX=2.E-3
      GNBL=5.
      GPWR=2.
      DO 64 IY=1,5
   64 BYFRAC(IY)=(FLOAT(IY)/GNBL)**GPWR*DELMAX/(10.*GH)
      DEL=(1.-DELMAX/(10.*GH))/(FLOAT(NY)-GNBL)
      DO 65 IY=6,NY
   65 BYFRAC(IY)=BYFRAC(IY-1)+DEL
      BZFRAC(1)=42.373E-3
      DO 66 IZ=2,8
   66 BZFRAC(IZ)=42.373E-3+BZFRAC(IZ-1)
      DO 67 IZ=9,14
   67 BZFRAC(IZ)=84.75E-3+BZFRAC(IZ-1)
      DO 68 IZ=15,16
   68 BZFRAC(IZ)=42.373E-3+BZFRAC(IZ-1)
      DO 69 IZ=17,22
   69 BZFRAC(IZ)=11.295E-3+BZFRAC(IZ-1)
      CALL DOMAIN(1,1,NX,1,NY,1,NZ)
      DO 61 IX=1,NXP1
      DO 62 IY=1,NYP1
      ZL(IX,IY,1)=0.0
   62 ZH(IX,IY,1)=GTL
      DO 63 IZ=1,NZP1
      YN(IX,IZ,1)=10*GH
   63 YS(IX,IZ,1)=0.0
      DO 663 IZ=6,20
  663 YS(IX,IZ,1)=(BZFRAC(IZ-1)-BZFRAC(5))*GTAB*GTL
      DO 664 IIZ=21,22
  664 YS(IX,IIZ,1)=YS(IX,20,1)
   61 CONTINUE
      STORSA(IFIX(LOW))=.TRUE.
```

```
      STORSA(IFIX(HIGH))=.TRUE.
      STORSA(IFIX(SOUTH))=.TRUE.
      STORWD(IFIX(SOUTH))=.TRUE.
      PRTBFC=.TRUE.
CDAR  DARCY=1.E10
C-------------------    --------------    -------------------
C---  GROUP 7. BLOCKAGE: BLOCK<.F.>,IPLANE,IPWRIT
C     *SET CONSTANT POROSITIES OVER SUB-DOMAINS USING:
C      CALL CONPOR(IR,TYPE,VALUE,IXF,IXL,IYF,IYL,IZF,IZL), WHERE:
C      IR=RUN SECTION NUMBER, E.G. 1 FOR RUN1 SECTION; 'TYPE'= EAST,
C      WEST, NORTH, SOUTH, HIGH, LOW & CELL. 'VALUE'=WANTED POROSITY
C      OVER REGION IXF,...IZL.
C     *DIMENSION ARRAYS PE(NX,NY,NZ), PN(NX,NY,NZ), PH(NX,NY,NZ), &
C      PC(NX,NY,NZ) ABOVE.
C     *FOR FULLY-BLOCKED CELLS (IE. 'VALUE'= 0.0) USER NEED SET ONLY
C      THE 'CELL' POROSITY (TO ZERO), AS CELL-FACE AREAS ARE THEN
C      AUTOMATICALLY ZEROED.
C     *FOR SATELLITE PRINTOUT OF ALL POROSITIES IN DOMAIN, 'IPLANE'=
C      XPLANE YPLANE OR ZPLANE, FOR DESIRED CROSS-SECTION DIRECTION.
C     *FOR EACH 'TYPE' A MAXIMUM OF 10 CALLS TO CONPOR IS ALLOWED,
C      BUT IF REQUIREMENTS EXCEED THIS PROVISION SET BLOCK=.T. &
C      IPWRIT=-1, AND SET POROSITY ARRAYS EXPLICITLY HERE AS WANTED.
C      IN THIS CASE, THE USER  M U S T  SET  A L L  ELEMENTS OF
C      ARRAYS PE, PN, PH, PC (MANY MAY BE 0.0 OR 1.0). HE MAY USE:
C      CALL CR(PARRAY,VALUE,IXF,IXL,IYF,IYL,IZF,IZL,NX,NY,NZ)
C      ANY NUMBER OF TIMES, TO SET 'PARRAY' (= PE, ETC.) TO
C      'VALUE' OVER RANGE IXF TO IXL, IYF TO IYL, IZF TO IZL.
C     *CONPOR  M U S T  N O T  BE USED IN CONJUNCTION WITH EXPLICIT
C      SETTINGS OF THE ARRAYS (INCLUDING SETTINGS VIA CR).
C-------------------    --------------    -------------------
C---  GROUP 8.DEPENDENT VARIABLES TO BE SOLVED FOR OR STORED :
C      SOLVAR(1-25)<25*.F.>,STOVAR(1-25)<25*.F.>,CONC1(1-4)<4*.T.>
C      USE FOLLOWING NAMED INTEGERS FOR ARRAY ELEMENTS 1-20:
C      P1,PP,U1,U2,V1,V2,W1,W2,M1,M2,RS,KE,EP,H1,H2,H3,C1,C2,C3,C4.
      SOLVAR(P1)=.TRUE.
```

```
      SOLVAR(PP)=.TRUE.
      SOLVAR(V1)=.TRUE.
      SOLVAR(W1)=.TRUE.
      SOLVAR(H1)=.TRUE.
      SOLVAR(KE)=.TRUE.
      SOLVAR(EP)=.TRUE.
      STOVAR(V2)=.TRUE.
      STOVAR(W2)=.TRUE.
      STOVAR(C1)=.TRUE.
      STOVAR(C2)=.TRUE.
C-------------------    ---------------    ------------------
C---  GROUP 9. VARIABLE LABELS :
C     TITLE(1-25)<2HP1,2HPP,2HU1,2HU2,2HV1,2HV2,2HW1,2HW2,2HR1,
C     2HR2,2HRS,2HKE,2HEP,2HH1,2HH2,2HH3,2HC1,2HC2,
C     2HC3,2HC4,2HRX,2HRY,2HRZ, 2*4H****>
C     TITLE(C1)=4HMACH
C     TITLE(C2)='TEMP'
C     TITLE(PP)='RHO1'
C-------------------    ---------------    ------------------
C---  GROUP 10 PROPERTIES:
C     IRHO1<1>,IRHO2<1>,RHO1<1.0>,RHO2<1.0>,
C     ARHO1<1.0>,BRHO1<1.0>,CRHO1<1.0>
C     IEMU1<1>,EMU1<1.0>,EMULAM<1.E-10>
C     IHSAT,H1SAT,H2SAT,PSATEX<1.0>
C     SIGMA(1-25)<1.0,2.0,1.,1.E10,1.,1.E10,1.,1.E10,
C     4*1.0,1.314,1.0,1.E10,10*1.0>
      IRHO1=4
      PTOT=55.E5
      TOT=555.55
      RAIR=287.
      GAMA=1.35
      CP=RAIR/(1-1/GAMA)
      TW=323.
      HWALL=TW*CP
      HTOT=CP*TOT
```

```
      RHTOT=PTOT/TOT/RAIR
      LOGIC(87)=.TRUE.
      ARHO1=RHTOT/PTOT**(1/GAMA)
      BRHO1=1./GAMA
C  TURBULENT FLOW
      IEMU1=2
      EMU1=4.E-5
      EMULAM=1.E-5
      SIGMA(24)=0.7
      SIGMA(14)=0.9
C------------------    --------------    ------------------
C---  GROUP 11 INTER-PHASE TRANSFER PROCESSES :
C     ICFIP,CFIPS,IMDOT,CMDOT,CA1I<1.E6>,CA2I<1.E6>
C------------------    --------------    ------------------
C---  GROUP 12 SPECIAL SOURCES :
C     ISPCSO(1-25),AGRAVX,AGRAVY,AGRAVZ,ABUOY,HREF
C------------------    --------------    ------------------
C---  GROUP 13 INITIAL FIELDS :
C     FIINIT(1-25)<25*1.E-10>
C    MACH NO. OF FREE STREAM
      GMACH=3.2
      A=1+(GAMA-1)/2*GMACH**2
      TE=TOT/A
      RHE=RHTOT/A**(1/(GAMA-1))
      PSTAT=PTOT/A**(GAMA/(GAMA-1))
      RHO1=ARHO1*PSTAT**BRHO1
      SONIC=SQRT(GAMA*RAIR*TE)
      WIN=SONIC*GMACH
      RKEIN=0.0001*WIN**2
      EPIN=0.16*RKEIN**1.5/(2.0*GH)
      FIINIT(W1)=WIN
      FIINIT(P1)=PSTAT
      FIINIT(H1)=HTOT
      FIINIT(KE)=RKEIN
      FIINIT(EP)=EPIN
```

```
C------------------    --------------    ------------------
C---  GROUP 14 BOUNDARY/INTERNAL CONDITIONS :
C     ILOOP1,ILOOPN,XCYCLE<.F.>,PBAR,REGION(1-10)<10*.T.>
C    *N.B. ALL 10 REGIONS ARE DEFAULTED .TRUE..  THE USER SHOULD
C     SET REGION(I)=.FALSE. FOR UNUSED REGIONS 'I'.
      DO 14 I=1,10
  14  REGION(I)=.FALSE.
C------------------    --------------    ------------------
C---  GROUP 15 TO 24; REGIONS 1 TO 10
C---  ONLY THOSE REGIONS ARE ACTIVE WHICH ARE SPECIFIED BY THE
C     USER, PREFERABLY BY WAY OF:-
C     CALL PLACE(IREGN,TYPE,IXF,IXL,IYF,IYL,IZF,IZL) &
C     CALL COVAL(IREGN,VARBLE,COEFF,VALUE)
      CALL PLACE(1,LOW,1,NX,1,NY,1,1)
C     CALL COVAL(1,M1,FIXFLU,WIN*RHE)
CDAR  CALL COVAL(1,M1,1.E-20,1.E+20*WIN*RHE)
      GCM=2*GAMA/WIN/(GAMA-1)
      GVM=PTOT*RHE/RHTOT
      CALL COVAL(1,M1,GCM,GVM)
      CALL COVAL(1,W1,ONLYMS,WIN)
      CALL COVAL(1,H1,ONLYMS,HTOT)
      CALL COVAL(1,KE,ONLYMS,RKEIN)
      CALL COVAL(1,EP,ONLYMS,EPIN)
      CALL PLACE(2,HIGH,1,NX,1,NY,NZ,NZ)
C     CALL COVAL(2,M1,FIXVAL,PSTAT*0.)
      CALL COVAL(2,M1,1000*WIN*RHE/PSTAT,PSTAT)
C   WALL ALONG THE VANE  IZ(6,22)
      GCM=EMU1/(.5*BYFRAC(1)*10.*GH)
      CALL PLACE(3,SOUTH,1,NX,1,1,6,22)
      CALL COVAL(3,W1,WALL,0.)
      CALL COVAL(3,H1,WALL,HWALL)
      CALL COVAL(3,KE,WALL,0.)
      CALL COVAL(3,EP,WALL,0.)
C------------------    --------------    ------------------
C---  GROUP 25 GROUND STATION :
```

```
C     GROSTA<.F.>,NAMLST<.F.>
C    *NAMLST ACTIVATES NAMELIST IN GROUND.
      GROSTA=.TRUE.
C------------------    --------------    ------------------
C---  GROUP 26 SOLUTION TYPE AND RELATED PARAMETERS :
C     WHOLEP<.F.>,SUBPST<.F.>,DONACC<.F.>
      WHOLEP=.TRUE.
C------------------    --------------    ------------------
C---  GROUP 27 SWEEP AND ITERATION NUMBERS :
C     FSWEEP<1>,LSWEEP<1>,LITHYD<1>,LITC<1>,LITKE<1>,LITH<1>,
C     LITER(1-25)<9*1,-1,15*1>
C     IVELF<1>,NVEL<1>,IVELL<10000>,
C     IKEF<1>,NKE<1>,IKEL<10000>,
C     IENTF<1>,NENT<1>,IENTL<10000>,
C     ICNCF<1>,NCNC<1>,ICNCL<10000>,
C     IRHO1F<1>,NRHO1<1>,IRHO1L<10000>,
C     IRHO2F<1>,NRHO2<1>,IRHO2L<10000>
      LSWEEP=100
      GSWP=LSWEEP
CR    FSWEEP=200
      LITER(PP)=20
      LITER(V1)=2
      LITER(W1)=5
      LITER(KE)=2
      LITER(EP)=2
C     LITHYD=2
C------------------    --------------    ------------------
C---  GROUP 28 TERMINATION CRITERIA :
C     ENDIT(1-25)<9*1.E-10,0.5,15*1.E-10>
      ENDIT(1)=1.E-5
C------------------    --------------    ------------------
C---  GROUP 29 RELAXATION  :
C     RLXP<1.>,RLXPXY<1.>,RLXPZ<1.>,RLXRHO<1.>,RLXMDT<1.>,
C     DTFALS(3-25)<23*1.E10>
      DTFALS(W1)=1.E-5
```

```
      DTFALS(V1)=1.E-3
      DTFALS(KE)=1.E-2
      DTFALS(EP)=1.E-4
      RLXP=.2
C-------------------    --------------    ------------------
C---  GROUP 30 LIMITS :
C     VELMAX<1.E10>,VELMIN<-1.E10>,RHOMAX<1.E10>,RHOMIN<1.E-10>,
C     TKEMAX<1.E10>,TKEMIN<1.E-10>,EMUMAX<1.E10>,EMUMIN<1.E-10>,
C     EPSMAX<1.E10>,EPSMIN<1.E-10>,AMDTMX<1.E10>,AMDTMN<-1.E10>
C-------------------    --------------    ------------------
C---  GROUP 31 SLOWING DEVICES : SLORHO<1.>,SLOEMU<1.>
      SLORHO=.5
C-------------------    --------------    ------------------
C---  GROUP 32 PRINT-OUT OF VARIABLES :
C     PRINT(1-25)<.T.,.F.,23*.T.>,SUBWGR<.F.>
      PRINT(C1)=.TRUE.
      PRINT(C2)=.TRUE.
      PRINT(PP)=.TRUE.
C-------------------    --------------    ------------------
C---  GROUP 33 MONITOR PRINT-OUT :
C     IXMON<1>,IYMON<1>,IZMON<1>,NPRMON<1>,NPRMNT<1>
      NPRMON=5
      IYMON=2
      IZMON=5
C-------------------    --------------    ------------------
C---  GROUP 34 FIELD PRINT-OUT CONTROL :
C     NPRINT<100>,NTPRIN<100>,NXPRIN<1>,NYPRIN<1>,NZPRIN<1>,
C     IZPRF<1>,ISTPRF<1>,IZPRL<10000>,ISTPRL<10000>
C     NUMCLS<10>,KOUTPT
      NPRINT=LSWEEP
      NUMCLS=5
C-------------------    --------------    ------------------
C---  GROUP 35 TABLE CONTROL :
C     TABLES<.F.>,NTABLE,NTABVR,LINTAB,NPRTAB,NMON,
C     ITAB(1-8),MTABVR(1-8)
```

```
C-------------------    ---------------    --------------------
C      GROUP 36-38 ARE NOT DOCUMENTED IN THE INSTRUCTION
C      MANUAL AND ARE INTENDED FOR MAINTENANCE PURPOSES ONLY
C---   GROUP 36 DEBUG PRINT-OUT SLAB AND TIME-STEP :
C      IZPR1<1>,IZPR2<1>,ISTPR1<1>,ISTPR2<1>
C-------------------    ---------------    --------------------
C---   GROUP 37 DEBUG SWEEP AND SUBROUTINES :
C      KEMU,KMAIN,KINDEX,KGEOM,KINPUT,KSODAT,KCOMPF,KSORCE,
C      KSOLV1,KSOLV2,KSOLV3,KCOMPP,KADJST,KFLUX,KSHIFT,KDIF,
C      KCOMPU,KCOMPV,KCOMPW,KCOMPR,KWALL,KDBRHO<-1>,KDBEXP,KDBMDT
C      KDBGEN
C-------------------    ---------------    --------------------
C---   GROUP 38 MONITOR,TEST,AND FLAG :
C      MONITR<.F.>,FLAG<.F.>,TEST<.T.>,KFLAG<1>
C      END OF MAINTENANCE-ONLY SECTION
C-------------------    ---------------    --------------------
C---   GROUP 39 ERROR AND RESIDUAL PRINT-OUT :
C      IERRP<1000>,RESREF(1,3-24)<25*1.>,RESMAP<.F.>,
C      RESID(1-25)<2*.F.,23*.T.>,KOUTPT
       RESREF(1)=WIN*RHE
       RESREF(7)=WIN*RESREF(1)
       RESREF(5)=WIN*RESREF(1)*0.1
       RESREF(H1)=HTOT*RESREF(1)
       RESREF(KE)=RKEIN*RESREF(1)
       RESREF(EP)=EPIN*RESREF(1)
       IERRP=LSWEEP/10
       KOUTPT=LSWEEP/10
C-------------------    ---------------    --------------------
C---   GROUP 40 SPECIAL DATA : LOGIC(1..10),INTGR(1..10),RE(21..30),
C      NLSP<1>,NISP<1>,NRSP<1>,SPDATA<.F.>,LSPDA(1),ISPDA(1),RSPDA(1)
C      USE FIRST 10 ELEMENTS OF ARRAYS LOGIC & INTGR AND 21ST
C      TO 30TH OF ARRAY RE FOR TRANSFERRING SPECIAL DATA FROM
C      SATELLITE TO GROUND, BUT IF REQUIREMENTS EXCEED THIS
C      PROVISION SET SPDATA = .T., AND DIMENSION ARRAYS LSPDA,
C      ISPDA, RSPDA ABOVE AND IN GROUND AS NEEDED, AND SET HERE
```

```
C-----------------------------------------------------------
C---  GROUP 42 RESTARTS AND DUMPS : SAVEM<.F.>,RESTRT<.F.>,KINPUT
      SAVEM=.TRUE.
      BFPLOT=.TRUE.
C     RESTRT=.TRUE.
C------------------    --------------    ------------------
C------------------    --------------    ------------------
C---  GROUP 43 GRAFFIC :
C     GRAPHS<.F.>,ORTHOG<.T.>,ANTSYM,NPRT<1>,ITITL<5*4H****>
C---  FOR A GRAFFIC RUN, DIMENSION PHI1 & PHI2 AS FOLLOWS:
C     PHI1(NX*NY*NZ*NM)
C     PHI2((NX+2)*(NY+2)*(NZ+2)*(NM+IBLK)) , WHERE
C     NM=NO. OF VARIABLES STORED + DENSITY(-IES)
C     IBLK=0 IF BLOCK=.FALSE.,=4 IF A 3D RUN,
C     =3 IF A 2D.YZ RUN.
C------------------    --------------    ------------------
          IF(IRUN.EQ.1) GO TO 900
  900 CONTINUE
C---  ALL RUNS
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 3 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 4 STARTS:
C-----------------------------------------------------------
C  WRITE GENERAL DATA ON TO THE GUSIE1.DTA TAPE, ETC...
          IF(SPDATA) CALL WRTSPC(LSPDA,NLSP,ISPDA,NISP,RSPDA,NRSP)
          IF(BLOCK) CALL WRTPOR(PE,PN,PH,PC,NX,NY,NZ,IPLANE)
       IF(BFC) CALL WRTBFC(14,NBFC,XE,XW,YN,YS,ZH,ZL,
      &ND,NX+1,NY+1,NZ+1,NZ,PRTBFC)
C     OLD PRACTICES RETAINED FOR REFERENCE:
C          IF(SPDATA) CALL SPCDAT(IRUN)
C          IF(BLOCK) CALL PORDAT(IRUN)
          IF(GRAPHS) CALL SORT(IRUN)
          IF(RESTRT) GO TO 902
        DO 901 INDVAR=1,25
          IF(IFIX(FIINIT(INDVAR)+0.1).NE.10101) GO TO 901
       CALL FLDDAT(IRUN)
```

```
      GO TO 902
  901 CONTINUE
  902 CALL DATAIO(WRT,10)
          IF(MONITR) CALL DATAIO(WRT,-6)
  999 CONTINUE
      STOP
      END
C***   IGEN=1 SO BFCXYZ NOT REQUIRED.
C***   COMMENT OUT BOTH VERSIONS.
C-------------------------------------------------------------
      SUBROUTINE BFCXYZ (NXP1,NYP1,NZP1)
      RETURN
      END
```

APPENDIX G

GROUND PROGRAM OF PHOENICS USED IN TURBULENT FLOW ANALYSIS

```
C$DIRECTIVE**MAIN
C     GROUND PROGRAM OF PHOENICS USED IN TURBULENT FLOW ANALYSIS
C     NZ=22 NY=25 LAMINAR FLOW
C    *FILE NAME: MODBFCGD.FTN
C    *INCLUDE DED SUBROUTINES: THE MODELS OF MAIN, GROUND & STRIDE.
C    *DOCUMENTATION: PHOENICS INSTRUCTION MANUAL (SPRING 1983)
C     WITH BODY-FITTED COORDINATES INSTRUCTION SUPPLEMENT
C     (SUMMER 1984).
C    *SATELLITE FILE NAME: MODSTL.FTN
      COMMON/ISHIFT/III(57),NFMAX
C SET F-ARRAY DIMENSION AS NEEDED, & SET NFMAX ACCORDINGLY.
C     FOR BFC'S ALSO SET F1-ARRAY DIMENSION AS NEEDED ,AND SET
C     NF1MAX ACCORDINGLY.
      COMMON/F0B/F1(10000)
      COMMON/NF0B/NF1MAX
      COMMON F(25000)
      NFMAX=25000
      NF1MAX=10000
      CALL MAIN1
      STOP
      END
C$DIRECTIVE**GROUND
      SUBROUTINE GROUND(IRN,ICHAP,ISTP,ISWP,IZED,INDVAR)
      INCLUDE (CMNGUS)
      INCLUDE (GUSSEQ)
C      INCLUDE NMLIST
      LOGICAL BFC
      EQUIVALENCE (LOGIC(20),BFC)
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 1 STARTS:
C-------------------------------------------------------------
```

```
C+++++MEANING OF SUBROUTINE ARGUMENTS:
C     IRN=RUN NUMBER; ICHAP=CHAPTER CALLED; ISTP=TIME STEP;
C     ISWP=SOLUTION SWEEP; IZED=Z-SLAB; INDVAR: SEE CHAPTERS BELOW.
C+++++USER-INTRODUCED VARIABLES & ARRAYS:
C     TO AVOID CONFLICT WITH VARIABLE NAMES USED IN COMMON, ALL
C     VARIABLES INTRODUCED BY THE USER SHOULD HAVE NAMES STARTING
C     WITH 'G' IF REAL, 'J' IF INTEGER, AND 'G' OR 'J' IF LOGICAL.
C     THUS GDZ(IZ) MIGHT BE A Z-INTERVAL ARRAY;
C     GW1(IY,IX) A 2-D ARRAY FOR AXIAL VELOCITY; ETC.
C     USER-GENERATED SUBROUTINES SHOULD BE NAMED CORRESPONDINGLY,EG
C     SUBROUTINE GVISC(GTEMP,GCNC,GVSC), FOR COMPUTING VISCOSITY
C     FROM CONCENTRATION & TEMPERATURE.
C+++++GROUND-TO-EARTH CONNECTING SUBROUTINES:
C    *USE GET(NAME,GARRAY,NY,NX) TO PUT VALUES OF VARIABLE NAMED
C     'NAME' INTO ARRAY 'GARRAY' DIMENSIONED GARRAY(NY,NX).
C    *USE SET(NAME,IXF,IXL,IYF,IYL,GARRAY,NY,NX) TO SET VARIABLE
C     'NAME' TO GARRAY(IY,IX) OVER THE REGION: IXF-IXL & IYF-IYL.
C    *USE PRNSLB(NAME) TO PRINT VARIABLE 'NAME' OVER X-Y PLANE.
C    *USE ADD(NAME,IXF,IXL,IYF,IYL,TYPE,CM,VM,CVAR,VVAR,NY,NX)
C     TO ADD SOURCE TO VARIABLE NAMED 'NAME' (SEE CHAPTER 5).
C    *USE READIZ(IZED) IN CHAPTERS 1, 2, 8, & 9 TO ACCESS P1,...DM
C     & VOL,...AHDZ. (SEE FOOTNOTE TO LEGALITY TABLE)
C    *USE GET1D(NAME,GARRAY,NDIM) TO PUT VARIABLE NAMED 'NAME' IN
C     ONE-D ARRAY 'GARRAY' DIMENSIONED NDIM, THUS:
C     CALL GET1D(NAME,GNX,NX) FOR XG,...DXG & DIMENSION GNX(NX);
C     CALL GET1D(NAME,GNY,NY) FOR YG,...RV & DIMENSION GNY(NY);
C     CALL GET1D(NAME,GNZ,NZ) FOR ZG,...WGRID & DIMENSION GNZ(NZ).
C+++++LEGALITY TABLE FOR USE OF EARTH-CONNECTING SUBROUTINES:
C     ENTRIES IN TABLE GIVE CHAPTERS IN WHICH SUBROUTINES CAN BE
C     USED FOR VARIABLES IN LEFT-HAND COLUMN. (SUBROUTINE
C     STRIDE IS REGARDED AS BEING IN CHAPTER 3)
C     ------------------------------------------------------------
C     : VARIABLE:: GET &  :  SET  : ADD    : READIZ : GET1D :
C     :          :: PRNSLB :      :        :        :       :
C     ------------------------------------------------------------
```

```
C     :P1 - RZ  ::    ALL    : 6 & 7 :   5    : 1,2,8,9:  NONE  :
C     :P10 - RZH::3-7, 10-16:    3   :  NONE  :  NONE  :  NONE  :
C     :VOL -AHDZ::    ALL    :    3   :  NONE  : 1,2,8,9:  NONE  :
C     :D1DP     ::    NONE   :   10   :  NONE  :  NONE  :  NONE  :
C     :D2DP     ::    NONE   :   11   :  NONE  :  NONE  :  NONE  :
C     :MU1,MU1H ::  5,13-16  :   12   :  NONE  :  NONE  :  NONE  :
C     :EXCO(L,H)::    NONE   :   13   :  NONE  :  NONE  :  NONE  :
C     :CFP      ::     5     :   14   :  NONE  :  NONE  :  NONE  :
C     :MDT      ::     5     :   15   :  NONE  :  NONE  :  NONE  :
C     :HST1,HST2::  5 & 15   :   16   :  NONE  :  NONE  :  NONE  :
C     :XG -WGRID::    NONE   :  NONE  :  NONE  :  NONE  :  ALL   :
C     ------------------------------------------------------------
C     NOTES ON ABOVE TABLE:
C    *IN CHAPTERS 1, 2, 8, & 9 VARIABLES P1...DM & GEOMETRY
C     VOL...AHDZ CAN BE ACCESSED BUT ONLY IN CONJUNCTION WITH
C     USE OF READIZ, THUS:
C     DO 1 IZED=1,NZ
C     CALL READIZ(IZED)
C   1 CALL GET(... AS REQUIRED..)
C    *GEOMETRY ACCESSED BY READIZ IS THAT AT INITIAL TIME.
C    *D1DP & D2DP ONLY ACCESSIBLE IN UNSTEADY FLOWS.
C+++++GROUND SERVICE SUBROUTINES:
C    *USE CONTUR(NAME,IPLANE,ILOC,NINT,I1,I2,J1,J2,GARRAY,NDIM) FOR
C     LINE-PRINTER PLOTS OF CONTOURS. 'NAME' = U1,...C4;
C     'IPLANE'= XPLANE, YPLANE, OR ZPLANE; ILOC SETS IX, IY, OR
C     IZ LOCATION OF IPLANE; I1, I2, J1, & J2 SET FIRST & LAST
C     CELLS IN HORIZ. & VERT. ON PLOT; GARRAY IS 1-D WORKING ARRAY
C     OF DIMENSION NX*NY, NX*NZ, OR NY*NZ DICTATED BY IPLANE; &
C     NDIM SETS VALUE OF DIMENSION OF GARRAY.
C    *USE FLD2DA(TITLE,GARRAY,NY,NX) TO PRINT ANY ARRAY DIMENSIONED
C     GARRAY(NY,NX); SET 'TITLE' TO REQUIRED NAME ( 4 HOLLERITH
C     CHARACTERS ONLY).
C    *USE FLD3DA(TITLE,GARRAY,NX,NY,NZ,IPLANE,ILOC) TO PRINT ANY
C     ARRAY DIMENSIONED GARRAY(NX,NY,NZ) IN PLANE SPECIFIED BY
C     'IPLANE' & 'ILOC' AS FOR CONTUR ABOVE; SET 'TITLE' AS FOR
```

```
C     FLD2DA.
C     VARIABLE NAMES FOR USE IN GROUND:
      COMMON/TYPE/CELL,EAST,WEST,NORTH,SOUTH,HIGH,LOW,VOLUME,WALL
      COMMON/VAR/P1,PP,U1,U2,V1,V2,W1,W2,R1,R2,RS,
     4.12,EP,H1,H2,H3,C1,C2,C3,C4,RX,RY,RZ,S1,S2
      COMMON/VAROLD/P10,PP0,U10,U20,V10,V20,W10,W20,R10,R20,RS0,
     &KE0,EP0,H10,H20,H30,C10,C20,C30,C40,RX0,RY0,RZ0,S10,S20
      COMMON/VARLOW/P1L,PPL,U1L,U2L,V1L,V2L,W1L,W2L,R1L,R2L,RSL,
     &KEL,EPL,H1L,H2L,H3L,C1L,C2L,C3L,C4L,RXL,RYL,RZL,S1L,S2L
      COMMON/VARHI/P1H,PPH,U1H,U2H,V1H,V2H,W1H,W2H,R1H,R2H,RSH,
     &KEH,EPH,H1H,H2H,H3H,C1H,C2H,C3H,C4H,RXH,RYH,RZH,S1H,S2H
      COMMON/GMTRY/VOL,VOLO,AEAST,ANORTH,AHIGH,AEDX,ANDY,AHDZ
      COMMON/PROP/D1,D2,D1DP,D2DP,MU1,MU1LAM,EXCO,CFP,MDT,HST1,HST2
      COMMON/PRPOLD/D10,D20
      COMMON/PRPLOW/D1L,D2L,EXCOL
      COMMON/PRPHI/D1H,D2H,MU1H,EXCOH
      COMMON/VARNX/XG,XU,DXU,DXG
      COMMON/VARNY/YG,YV,DYV,DYG,R,RV
      COMMON/VARNZ/ZG,ZW1,DZW,DZG,WGRID
      COMMON/GDMSCI/XPLANE,YPLANE,ZPLANE,ITNO
      COMMON/GDMSCL/LSLAB,MSLAB,HSLAB,LAMMU
      REAL NORTH,LOW
      INTEGER    P1,PP,U1,U2,V1,V2,W1,W2,R1,R2,RS,
     &EP,H1,H2,H3,C1,C2,C3,C4,RX,RY,RZ,S1,S2
      INTEGER    P10,PP0,U10,U20,V10,V20,W10,W20,R10,R20,RS0,
     &EP0,H10,H20,H30,C10,C20,C30,C40,RX0,RY0,RZ0,S10,S20
      INTEGER    P1L,PPL,U1L,U2L,V1L,V2L,W1L,W2L,R1L,R2L,RSL,
     &EPL,H1L,H2L,H3L,C1L,C2L,C3L,C4L,RXL,RYL,RZL,S1L,S2L
      INTEGER    P1H,PPH,U1H,U2H,V1H,V2H,W1H,W2H,R1H,R2H,RSH,
     &EPH,H1H,H2H,H3H,C1H,C2H,C3H,C4H,RXH,RYH,RZH,S1H,S2H
      INTEGER VOL,VOLO,AEAST,ANORTH,AHIGH,AEDX,ANDY,AHDZ
      INTEGER D1,D1DP,D2,D2DP,EXCO,CFP,HST1,HST2
      INTEGER D10,D20,D1L,D2L,EXCOL,D1H,D2H,EXCOH
      INTEGER XG,XU,DXU,DXG,YG,YV,DYV,DYG,R,RV,ZG,ZW1,DZW,
     &DZG,WGRID
```

```
      INTEGER XPLANE,YPLANE,ZPLANE
      LOGICAL LSLAB,MSLAB,HSLAB,LAMMU,LSPDA
      EQUIVALENCE (M1,R1),(M2,R2)
C     SATLIT-EQUIVALENT IRUN:
      EQUIVALENCE (IRUN,INTGR(11))
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 1 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 1 STARTS:
C     ARRAYS ( DIMENSIONED NY,NX ) FOR USE WITH 'ADD':
      DIMENSION CVAR(1,1),VVAR(1,1),CM(1,1),VM(1,1),ZERO(1,1)
      DIMENSION GP(30,1),GH(30,1),GD(30,1),GV(30,1),GW(30,1)
     1 ,GMACH(30,1),GTEMP(30,1)
C     SPECIAL-DATA ARRAYS DIMENSIONED & DIMENSION VALUES SET HERE:
      DIMENSION LSPDA(1),ISPDA(1),RSPDA(1)
C     USER PLACES HIS VARIABLES, ARRAYS, EQUIVALENCES ETC. HERE.
      EQUIVALENCE (RAIR,RE(21)),(GAMA,RE(22)),(GSWP,RE(23))
      DATA NLSP,NISP,NRSP/1,1,1/
      DATA CVAR,VVAR,CM,VM,ZERO/5*0.0/
C     USER PLACES HIS DATA STATEMENTS HERE.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 1 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 2 STARTS:
C     PLEASE DO NOT ALTER, OR RE-SET, ANY OF THE REMAINING
C     STATEMENTS OF THIS SECTION.
      DATA NUMCH4 / 0 /
          IF(SPDATA)
     &CALL RDSPC(IRN,INTGR(12),LSPDA,NLSP,ISPDA,NISP,RSPDA,NRSP)
      CALL GRDUTY(IRN,ICHAP,IZED,INDVAR)
      IF(BFC) CALL BFCGRD(IRN,ICHAP,ISWP,IZED,INDVAR)
          IF(ICHAP.EQ.-5) GO TO 10
          IF(ICHAP.LE.0.OR.ICHAP.GT.16) RETURN
      GO TO (100,200,300,4999,500,600,700,800,900,1000,1100,1200,
     &1300,1400,1500,1600),ICHAP
      RETURN
 4999 NUMCH4= NUMCH4 + 1
      IF (MOD(NUMCH4,2).EQ.1) GO TO 400
      RETURN
```

```
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX STANDARD SECTION 2 ENDS.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX USER SECTION 2 STARTS:
C-----------------------------------------------------------------
C     CHAPTER 0: MODIFY SATLIT DATA, AT START OF EACH IRN.
C-----------------------------------------------------------------
   10 CONTINUE
C          IF(.NOT.NAMLST) RETURN
C          IF(IRN.EQ.NRUN) DATFIL=.FALSE.
C---  READ SATLIT DATA NAMELIST HERE
C     CALL WRIT40(40HENTER NAMELIST DATA FOR GROUPS 1 TO 24  )
C     READ(20,G1G24)
C     CALL WRIT40(40HENTER NAMELIST DATA FOR GROUPS 25 TO 42 )
C     READ(20,G25G42)
      RETURN
C-----------------------------------------------------------------
C     CHAPTER 1: CALLED AT THE START OF EACH TIME STEP.
C     SET 'DT' HERE WHEN TLAST SET NEGATIVE IN BLOCK DATA.
C     'ATIME + DT' GIVES THE END TIME OF THE CURRENT TIME STEP.
C     NOT ACCESSED IF STEADY,OR PARABOLIC.
C-----------------------------------------------------------------
  100 CONTINUE
      RETURN
C-----------------------------------------------------------------
C     CHAPTER 2: CALLED AT THE START OF EACH SWEEP.
C-----------------------------------------------------------------
  200 CONTINUE
      RETURN
C-----------------------------------------------------------------
C     CHAPTER 3: CALLED AT THE START OF EACH SLAB;
C     NOT ACCESSED IF PARABOLIC, BUT 'STRIDE' IS.
C-----------------------------------------------------------------
  300 CONTINUE
      RETURN
C-----------------------------------------------------------------
C     CHAPTER 4: CALLED AT THE START OF EACH RE-CALCULATION OF
```

```
C     VARIABLES P1,...C4 AT CURRENT SLAB. ITNO= ITERATION NUMBER.
C-----------------------------------------------------------------
  400 CONTINUE
      RETURN
C-----------------------------------------------------------------
C     CHAPTER 5: GROUND CALLED WHEN SOURCE TERM IS COMPUTED.
C     INDVAR GIVES DEPENDENT VARIABLE IN QUESTION IE. U1,...C4.
C     TO ADD SOURCE TO DEPENDENT VARIABLE C1(SAY) FOR IX=IXF,IXL
C     AND IY=IYF,IYL INSERT STATEMENT:
C     IF(INDVAR.EQ.C1)
C    &CALL ADD(INDVAR,IXF,IXL,IYF,IYL,TYPE,CM,VM,CVAR,VVAR,NY,NX)
C     NOTES ON 'ADD':
C    *SOURCE= (CVAR(IY,IX)+AMAX1(0.0,MASFLO))*(VVAR(IY,IX)-PHI),
C     WHERE 'PHI' IS IN-CELL VALUE OF VARIABLE IN QUESTION.
C    *'MASFLO'= CM(IY,IX)*(VM(IY,IX)-P),
C     WHERE 'P' IS THE IN-CELL PRESSURE.
C    *FOR INDVAR= M1, OR =M2, SOURCE ADDED IS 'MASFLO' ONLY,
C     EXCEPT FOR ONEPHS=.F. & MASFLO < 0.0 (IE. OUTFLOW) WHEN
C     CM(IY,IX) IS MULTIPLIED BY R1*D1 (FOR M1) & R2*D2 (FOR M2).
C    *BOTH 'CVAR' & 'CM' ARE MUTLIPLIED BY CELL-GEOMETRY QUANTITY
C     DICTATED BY SETTING OF 'TYPE' (=CELL, EAST AREA,..VOLUME).
C    *TYPE-SPECIFIED AREAS ARE CALCULATED AS IF BLOCKAGE ABSENT,
C     BUT 'VOLUME' WITH ACCOUNT FOR ITS PRESENCE.
C    *FOR ALL SOLVED VARIABLES, INCLUDE DING M1 ( & M2 WHEN ONEPHS=F),
C     IF 'CM'> 0.0 CALL 'ADD'; FOR M1 & M2 ALTHOUGH 'CVAR' & 'VVAR'
C     HAVE NO SIGNIFICANCE THEY MUST BE ENTERED AS ARGUMENTS.
C    *'CVAR', 'VVAR', 'CM' & 'VM' MUST BE DIMENSIONED NY,NX.
C-----------------------------------------------------------------
  500 CONTINUE
      RETURN
C-----------------------------------------------------------------
C     CHAPTER 6: CALLED AT THE END OF EACH VARIABLE-RECALCULATION
C     CYCLE COMMENCED AT CHAPTER 4. ITNO = ITERATION NUMBER.
C-----------------------------------------------------------------
  600 CONTINUE
```

```
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 7: CALLED AT END OF EACH SLAB-WISE CALCULATION.
C-----------------------------------------------------------------------
  700 CONTINUE
      IF(FLOAT(ISWP).LT.GSWP) RETURN
      CALL GET(P1,GP,NY,NX)
      CALL GET(H1,GH,NY,NX)
      CALL GET(D1,GD,NY,NX)
      CALL GET(V1,GV,NY,NX)
      CALL GET(W1,GW,NY,NX)
      DO 701 I=1,NY
      GSON=SQRT(GAMA*GP(I,1)/GD(I,1))
      GAV=SQRT(GV(I,1)**2+GW(I,1)**2)
      GMACH(I,1)=GAV/GSON
  701 GTEMP(I,1)=GP(I,1)/GD(I,1)/RAIR
      CALL SET(C1,1,NX,1,NY,GMACH,NY,NX)
      CALL SET(C2,1,NX,1,NY,GTEMP,NY,NX)
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 8: CALLED AT THE END OF EACH SWEEP;
C     NOT ACCESSED IF PARABOLIC.
C-----------------------------------------------------------------------
  800 CONTINUE
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 9: CALLED AT THE END OF EACH TIME STEP;
C     NOT ACCESSED IF PARABOLIC.
C-----------------------------------------------------------------------
  900 CONTINUE
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 10: SET PHASE 1 DENSITY HERE WHEN IRHO1=-1 IN DATA.
C     SET CURRENT-Z 'SLAB' DENSITY, D1, IF MSLAB=.T.,
C     EG.  IF(MSLAB) CALL SET(D1,1,NX,1,NY,GD1,NY,NX).
```

```
C     SET NEXT LARGER-Z 'SLAB' DENSITY, D1H, IF HSLAB=.T. & PARAB=F
C     EG.  IF(HSLAB) CALL SET(D1H,1,NX,1,NY,GD1H,NY,NX).
C     SET D(LN(D1))/DP (IE. D1DP) FOR UNSTEADY FLOW,
C     EG.  IF(MSLAB) CALL SET(D1DP,1,NX,1,NY,GD1DP,NY,NX).
C-----------------------------------------------------------------------
 1000 CONTINUE
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 11: SET PHASE 2 DENSITY HERE WHEN IRHO2=-1 IN DATA.
C     SET CURRENT-Z 'SLAB' DENSITY, D2, IF MSLAB=.T.,
C     EG.  IF(MSLAB) CALL SET(D2,1,NX,1,NY,GD2,NY,NX).
C     SET NEXT LARGER-Z 'SLAB' DENSITY, D2H, IF HSLAB=.T. & PARAB=F
C     EG.  IF(HSLAB) CALL SET(D2H,1,NX,1,NY,GD2H,NY,NX).
C     SET D(LN(D2))/DP FOR UNSTEADY FLOW,
C     EG.  IF(MSLAB) CALL SET(D2DP,1,NX,1,NY,GD2DP,NY,NX).
C-----------------------------------------------------------------------
 1100 CONTINUE
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 12: SET PHASE 1 VISCOSITY HERE WHEN IEMU1=-1 IN DATA.
C     SET CURRENT-Z 'SLAB' VISCOSITY (MU1), IF MSLAB=.T.,
C     EG.  IF(MSLAB) CALL SET(MU1,1,NX,1,NY,GVISC,NY,NX);
C     SET NEXT LARGER-Z 'SLAB' VISC. (MU1H), IF HSLAB=.T. & PARAB=F
C     EG.  IF(HSLAB) CALL SET(MU1H,1,NX,1,NY,GVSCH,NY,NX).
C
C     CHAPTER ALSO ACCESSED WHEN EMULAM=-1.0 IN DATA, SO THAT THE
C     LAMINAR VISCOSITY WHICH APPEARS IN WALL FUNCTIONS & IN THE
C     KE-EP TURBULENCE MODEL (IEMU1=2) MAY BE SET NON-CONSTANT.
C     SET CURRENT-Z 'SLAB' VALUE (MU1LAM) WHEN LAMMU=.T.,
C     EG.  IF(LAMMU) CALL SET(MU1LAM,1,NX,1,NY,GVSCL,NY,NX).
C-----------------------------------------------------------------------
 1200 CONTINUE
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 13: SET EXCHANGE COEFFICIENT (E.C.) FOR VARIABLE
```

```
C     INDVAR WHEN SIGMA(INDVAR)=-1.0 IN DATA.
C     SET CURRENT-Z 'SLAB' E.C. (EXCO) IF MSLAB=.T.,
C     EG.  IF(MSLAB) CALL SET(EXCO,1,NX,1,NY,GEXCO,NY,NX).
C     SET NEXT SMALLER-Z 'SLAB' E.C. (EXCOL) IF LSLAB=.T.,
C     EG.  IF(LSLAB) CALL SET(EXCOL,1,NX,1,NY,GEXCOL,NY,NX).
C     SET NEXT LARGER-Z  'SLAB' E.C. (EXCOH) IF HSLAB=.T.,
C     EG.  IF(HSLAB) CALL SET(EXCOH,1,NX,1,NY,GEXCOH,NY,NX).
C     NOTE: FOR MSLAB, INDVAR=U1,..C4; FOR LSLAB, INDVAR=U1L,..C4L
C     & FOR HSLAB, INDVAR=U1H,..C4H. IF PARAB=.T. SET MSLAB ONLY.
C-----------------------------------------------------------------------
 1300 CONTINUE
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 14: SET INTER-PHASE FRICTION COEFFICIENT (CFP) HERE
C     WHEN ICFIP = -1 IN DATA; ITS UNITS = FORCE / (CELL * RELATIVE
C     SPEED OF PHASES).
C-----------------------------------------------------------------------
 1400 CONTINUE
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 15: SET INTER-PHASE MASS-TRANSFER RATE PER CELL (MDT)
C     HERE WHEN IMDOT = -1 IN DATA.
C-----------------------------------------------------------------------
 1500 CONTINUE
      RETURN
C-----------------------------------------------------------------------
C     CHAPTER 16: SET HERE PHASE 1 & 2 SATURATION ENTHALPIES
C     ( HST1 & HST2) WHEN IHSAT = -1 IN DATA.
C-----------------------------------------------------------------------
 1600 CONTINUE
      RETURN
      END
```

APPENDIX H

TURBULENT OUTPUT FLOW FIELD

DATA TAKEN FROM DEFAULT.DTA ON GROUP A/C
FILE MODSTL.FTN IS THE SATLIT USED.

BODY-FITTED-COORDINATE OPTION ACTIVE

F1 ARRAY IS DIMENSIONED TO = 5000
MINIMUM ALLOWABLE DIMENSION FOR F1 = 1318

FLOW FIELD AT, ISWEEP= 100, ISTEP= 1
FIELD VALUES OF M (mach)

IY=25	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=24	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=23	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=22	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=21	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=20	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=19	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=18	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=17	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=16	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=15	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.199E+00
IY=14	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.199E+00
IY=13	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.199E+00
IY=12	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.199E+00
IY=11	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.199E+00
IY=10	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.199E+00
IY= 9	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.198E+00
IY= 8	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.197E+00
IY= 7	3.200E+00	3.200E+00	3.200E+00	3.199E+00	3.194E+00
IY= 6	3.200E+00	3.200E+00	3.200E+00	3.198E+00	3.183E+00
IY= 5	3.200E+00	3.200E+00	3.200E+00	3.196E+00	3.157E+00
IY= 4	3.200E+00	3.200E+00	3.200E+00	3.195E+00	3.144E+00

IY= 3	3.200E+00	3.200E+00	3.200E+00	3.195E+00	3.132E+00
IY= 2	3.200E+00	3.200E+00	3.199E+00	3.195E+00	3.121E+00
IY= 1	3.200E+00	3.200E+00	3.199E+00	3.195E+00	3.114E+00
IZ=	1	2	3	4	5
IY=25	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=24	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=23	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=22	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00
IY=21	3.200E+00	3.200E+00	3.200E+00	3.199E+00	3.199E+00
IY=20	3.199E+00	3.199E+00	3.199E+00	3.199E+00	3.199E+00
IY=19	3.199E+00	3.199E+00	3.199E+00	3.199E+00	3.199E+00
IY=18	3.199E+00	3.199E+00	3.199E+00	3.199E+00	3.198E+00
IY=17	3.199E+00	3.199E+00	3.199E+00	3.198E+00	3.197E+00
IY=16	3.198E+00	3.198E+00	3.198E+00	3.198E+00	3.196E+00
IY=15	3.198E+00	3.198E+00	3.198E+00	3.197E+00	3.194E+00
IY=14	3.198E+00	3.197E+00	3.197E+00	3.195E+00	3.191E+00
IY=13	3.197E+00	3.197E+00	3.196E+00	3.193E+00	3.185E+00
IY=12	3.197E+00	3.196E+00	3.195E+00	3.189E+00	3.176E+00
IY=11	3.196E+00	3.195E+00	3.192E+00	3.181E+00	3.160E+00
IY=10	3.195E+00	3.194E+00	3.187E+00	3.168E+00	3.136E+00
IY= 9	3.193E+00	3.190E+00	3.176E+00	3.144E+00	3.101E+00
IY= 8	3.190E+00	3.181E+00	3.154E+00	3.106E+00	3.060E+00
IY= 7	3.179E+00	3.156E+00	3.112E+00	3.056E+00	3.022E+00
IY= 6	3.146E+00	3.097E+00	3.045E+00	3.010E+00	3.002E+00
IY= 5	3.082E+00	3.030E+00	3.012E+00	3.010E+00	3.008E+00
IY= 4	3.050E+00	3.010E+00	3.005E+00	3.007E+00	2.999E+00
IY= 3	3.022E+00	2.997E+00	2.995E+00	2.972E+00	2.894E+00
IY= 2	2.995E+00	2.946E+00	2.891E+00	2.726E+00	2.652E+00
IY= 1	2.556E+00	2.335E+00	2.046E+00	2.089E+00	2.084E+00
IZ=	6	7	8	9	10
IY=25	3.200E+00	3.200E+00	3.199E+00	3.199E+00	3.199E+00
IY=24	3.200E+00	3.200E+00	3.199E+00	3.199E+00	3.198E+00
IY=23	3.200E+00	3.199E+00	3.199E+00	3.198E+00	3.198E+00
IY=22	3.199E+00	3.199E+00	3.198E+00	3.197E+00	3.196E+00
IY=21	3.199E+00	3.198E+00	3.197E+00	3.195E+00	3.194E+00

IY=20	3.199E+00	3.198E+00	3.196E+00	3.193E+00	3.191E+00
IY=19	3.198E+00	3.196E+00	3.193E+00	3.189E+00	3.185E+00
IY=18	3.197E+00	3.194E+00	3.189E+00	3.183E+00	3.177E+00
IY=17	3.195E+00	3.191E+00	3.183E+00	3.173E+00	3.166E+00
IY=16	3.193E+00	3.185E+00	3.173E+00	3.160E+00	3.150E+00
IY=15	3.188E+00	3.177E+00	3.160E+00	3.141E+00	3.129E+00
IY=14	3.181E+00	3.165E+00	3.141E+00	3.118E+00	3.103E+00
IY=13	3.170E+00	3.146E+00	3.117E+00	3.091E+00	3.076E+00
IY=12	3.153E+00	3.122E+00	3.089E+00	3.064E+00	3.051E+00
IY=11	3.128E+00	3.092E+00	3.060E+00	3.040E+00	3.031E+00
IY=10	3.097E+00	3.061E+00	3.035E+00	3.022E+00	3.018E+00
IY= 9	3.061E+00	3.033E+00	3.017E+00	3.012E+00	3.011E+00
IY= 8	3.029E+00	3.013E+00	3.008E+00	3.007E+00	3.008E+00
IY= 7	3.008E+00	3.004E+00	3.004E+00	3.005E+00	3.007E+00
IY= 6	3.002E+00	3.003E+00	3.003E+00	3.004E+00	3.006E+00
IY= 5	3.005E+00	3.002E+00	2.997E+00	2.990E+00	2.986E+00
IY= 4	2.982E+00	2.954E+00	2.913E+00	2.865E+00	2.842E+00
IY= 3	2.801E+00	2.728E+00	2.680E+00	2.649E+00	2.637E+00
IY= 2	2.621E+00	2.588E+00	2.557E+00	2.531E+00	2.521E+00
IY= 1	2.069E+00	2.048E+00	2.026E+00	2.006E+00	1.997E+00
IZ=	11	12	13	14	15
IY=25	3.198E+00	3.198E+00	3.198E+00	3.198E+00	3.198E+00
IY=24	3.198E+00	3.198E+00	3.198E+00	3.198E+00	3.198E+00
IY=23	3.197E+00	3.197E+00	3.197E+00	3.197E+00	3.197E+00
IY=22	3.196E+00	3.195E+00	3.195E+00	3.196E+00	3.196E+00
IY=21	3.193E+00	3.193E+00	3.193E+00	3.193E+00	3.193E+00
IY=20	3.189E+00	3.189E+00	3.188E+00	3.189E+00	3.189E+00
IY=19	3.183E+00	3.182E+00	3.182E+00	3.182E+00	3.183E+00
IY=18	3.174E+00	3.173E+00	3.172E+00	3.172E+00	3.174E+00
IY=17	3.161E+00	3.159E+00	3.158E+00	3.158E+00	3.160E+00
IY=16	3.143E+00	3.141E+00	3.139E+00	3.139E+00	3.142E+00
IY=15	3.120E+00	3.118E+00	3.116E+00	3.116E+00	3.120E+00
IY=14	3.094E+00	3.091E+00	3.090E+00	3.090E+00	3.095E+00
IY=13	3.067E+00	3.065E+00	3.065E+00	3.066E+00	3.073E+00
IY=12	3.044E+00	3.044E+00	3.044E+00	3.046E+00	3.055E+00

IY=11	3.027E+00	3.028E+00	3.030E+00	3.033E+00	3.043E+00
IY=10	3.017E+00	3.019E+00	3.022E+00	3.026E+00	3.036E+00
IY= 9	3.012E+00	3.015E+00	3.019E+00	3.023E+00	3.033E+00
IY= 8	3.010E+00	3.014E+00	3.018E+00	3.022E+00	3.031E+00
IY= 7	3.010E+00	3.013E+00	3.017E+00	3.020E+00	3.028E+00
IY= 6	3.008E+00	3.011E+00	3.015E+00	3.020E+00	3.028E+00
IY= 5	2.983E+00	2.985E+00	2.990E+00	3.001E+00	3.005E+00
IY= 4	2.820E+00	2.818E+00	2.820E+00	2.835E+00	2.848E+00
IY= 3	2.628E+00	2.629E+00	2.636E+00	2.670E+00	2.707E+00
IY= 2	2.513E+00	2.515E+00	2.523E+00	2.574E+00	2.616E+00
IY= 1	1.990E+00	1.992E+00	2.000E+00	2.082E+00	2.127E+00
IZ=	16	17	18	19	20
IY=25	3.194E+00	3.194E+00			
IY=24	3.153E+00	3.154E+00			
IY=23	3.077E+00	3.078E+00			
IY=22	2.971E+00	2.973E+00			
IY=21	2.845E+00	2.848E+00			
IY=20	2.705E+00	2.711E+00			
IY=19	2.559E+00	2.567E+00			
IY=18	2.409E+00	2.422E+00			
IY=17	2.259E+00	2.277E+00			
IY=16	2.108E+00	2.134E+00			
IY=15	1.960E+00	1.993E+00			
IY=14	1.817E+00	1.856E+00			
IY=13	1.683E+00	1.727E+00			
IY=12	1.562E+00	1.609E+00			
IY=11	1.458E+00	1.503E+00			
IY=10	1.367E+00	1.410E+00			
IY= 9	1.289E+00	1.328E+00			
IY= 8	1.220E+00	1.254E+00			
IY= 7	1.157E+00	1.186E+00			
IY= 6	1.100E+00	1.121E+00			
IY= 5	1.058E+00	1.069E+00			
IY= 4	1.006E+00	1.015E+00			
IY= 3	9.719E-01	9.797E-01			

IY= 2	9.641E-01	9.697E-01			
IY= 1	8.192E-01	8.283E-01			
IZ=	21	22			

FIELD VALUES OF T (temprature)

IY=25	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=24	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=23	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=22	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=21	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=20	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=19	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=18	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=17	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=16	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=15	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=14	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=13	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=12	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=11	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=10	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY= 9	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY= 8	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY= 7	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.991E+02
IY= 6	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.993E+02
IY= 5	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.997E+02
IY= 4	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.998E+02
IY= 3	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.999E+02
IY= 2	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.999E+02
IY= 1	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.999E+02
IZ=	1	2	3	4	5
IY=25	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=24	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=23	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=22	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=21	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02

IY=20	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=19	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=18	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=17	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.990E+02
IY=16	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.991E+02
IY=15	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.992E+02
IY=14	1.990E+02	1.990E+02	1.990E+02	1.991E+02	1.993E+02
IY=13	1.990E+02	1.990E+02	1.990E+02	1.991E+02	1.996E+02
IY=12	1.990E+02	1.990E+02	1.990E+02	1.993E+02	2.001E+02
IY=11	1.990E+02	1.990E+02	1.991E+02	1.997E+02	2.011E+02
IY=10	1.990E+02	1.991E+02	1.993E+02	2.004E+02	2.028E+02
IY= 9	1.990E+02	1.992E+02	1.997E+02	2.019E+02	2.054E+02
IY= 8	1.992E+02	1.996E+02	2.008E+02	2.046E+02	2.090E+02
IY= 7	1.996E+02	2.010E+02	2.036E+02	2.090E+02	2.130E+02
IY= 6	2.013E+02	2.051E+02	2.096E+02	2.142E+02	2.156E+02
IY= 5	2.060E+02	2.123E+02	2.150E+02	2.153E+02	2.155E+02
IY= 4	2.090E+02	2.147E+02	2.160E+02	2.155E+02	2.154E+02
IY= 3	2.122E+02	2.160E+02	2.163E+02	2.155E+02	2.154E+02
IY= 2	2.146E+02	2.164E+02	2.163E+02	2.154E+02	2.154E+02
IY= 1	2.156E+02	2.163E+02	2.162E+02	2.154E+02	2.153E+02
IZ=	6	7	8	9	10
IY=25	1.990E+02	1.990E+02	1.990E+02	1.990E+02	1.991E+02
IY=24	1.990E+02	1.990E+02	1.990E+02	1.991E+02	1.991E+02
IY=23	1.990E+02	1.990E+02	1.990E+02	1.991E+02	1.991E+02
IY=22	1.990E+02	1.990E+02	1.991E+02	1.992E+02	1.992E+02
IY=21	1.990E+02	1.990E+02	1.991E+02	1.993E+02	1.994E+02
IY=20	1.990E+02	1.991E+02	1.992E+02	1.994E+02	1.996E+02
IY=19	1.990E+02	1.991E+02	1.993E+02	1.997E+02	2.000E+02
IY=18	1.991E+02	1.992E+02	1.996E+02	2.002E+02	2.006E+02
IY=17	1.991E+02	1.994E+02	2.000E+02	2.008E+02	2.014E+02
IY=16	1.993E+02	1.997E+02	2.006E+02	2.019E+02	2.027E+02
IY=15	1.995E+02	2.002E+02	2.015E+02	2.033E+02	2.043E+02
IY=14	1.999E+02	2.010E+02	2.028E+02	2.051E+02	2.064E+02
IY=13	2.006E+02	2.023E+02	2.047E+02	2.074E+02	2.088E+02
IY=12	2.017E+02	2.041E+02	2.070E+02	2.098E+02	2.111E+02

IY=11	2.035E+02	2.065E+02	2.096E+02	2.121E+02	2.131E+02
IY=10	2.060E+02	2.094E+02	2.121E+02	2.138E+02	2.144E+02
IY= 9	2.092E+02	2.122E+02	2.141E+02	2.150E+02	2.152E+02
IY= 8	2.124E+02	2.144E+02	2.153E+02	2.155E+02	2.155E+02
IY= 7	2.149E+02	2.155E+02	2.157E+02	2.157E+02	2.156E+02
IY= 6	2.157E+02	2.157E+02	2.157E+02	2.157E+02	2.156E+02
IY= 5	2.157E+02	2.158E+02	2.157E+02	2.157E+02	2.155E+02
IY= 4	2.157E+02	2.158E+02	2.157E+02	2.156E+02	2.155E+02
IY= 3	2.156E+02	2.157E+02	2.157E+02	2.156E+02	2.155E+02
IY= 2	2.157E+02	2.158E+02	2.158E+02	2.157E+02	2.156E+02
IY= 1	2.156E+02	2.157E+02	2.157E+02	2.156E+02	2.155E+02
IZ=	11	12	13	14	15
IY=25	1.991E+02	1.991E+02	1.991E+02	1.991E+02	1.991E+02
IY=24	1.991E+02	1.991E+02	1.991E+02	1.991E+02	1.991E+02
IY=23	1.992E+02	1.992E+02	1.992E+02	1.992E+02	1.992E+02
IY=22	1.993E+02	1.993E+02	1.993E+02	1.993E+02	1.993E+02
IY=21	1.995E+02	1.995E+02	1.995E+02	1.995E+02	1.995E+02
IY=20	1.998E+02	1.998E+02	1.999E+02	1.999E+02	1.999E+02
IY=19	2.003E+02	2.003E+02	2.004E+02	2.004E+02	2.004E+02
IY=18	2.010E+02	2.011E+02	2.012E+02	2.012E+02	2.013E+02
IY=17	2.021E+02	2.022E+02	2.023E+02	2.024E+02	2.024E+02
IY=16	2.035E+02	2.037E+02	2.039E+02	2.040E+02	2.040E+02
IY=15	2.054E+02	2.057E+02	2.059E+02	2.060E+02	2.060E+02
IY=14	2.077E+02	2.080E+02	2.082E+02	2.083E+02	2.082E+02
IY=13	2.100E+02	2.103E+02	2.104E+02	2.105E+02	2.103E+02
IY=12	2.121E+02	2.123E+02	2.123E+02	2.123E+02	2.120E+02
IY=11	2.137E+02	2.138E+02	2.137E+02	2.135E+02	2.131E+02
IY=10	2.147E+02	2.147E+02	2.145E+02	2.143E+02	2.138E+02
IY= 9	2.152E+02	2.151E+02	2.149E+02	2.146E+02	2.140E+02
IY= 8	2.154E+02	2.152E+02	2.150E+02	2.146E+02	2.141E+02
IY= 7	2.154E+02	2.152E+02	2.150E+02	2.146E+02	2.141E+02
IY= 6	2.154E+02	2.152E+02	2.150E+02	2.146E+02	2.139E+02
IY= 5	2.154E+02	2.152E+02	2.148E+02	2.142E+02	2.122E+02
IY= 4	2.154E+02	2.151E+02	2.148E+02	2.139E+02	2.105E+02
IY= 3	2.154E+02	2.151E+02	2.147E+02	2.136E+02	2.077E+02

IY= 2	2.155E+02	2.152E+02	2.149E+02	2.137E+02	2.036E+02
IY= 1	2.153E+02	2.151E+02	2.147E+02	2.136E+02	2.005E+02
IZ=	16	17	18	19	20
IY=25	1.991E+02	1.990E+02			
IY=24	1.991E+02	1.990E+02			
IY=23	1.992E+02	1.990E+02			
IY=22	1.993E+02	1.990E+02			
IY=21	1.995E+02	1.990E+02			
IY=20	1.998E+02	1.990E+02			
IY=19	2.003E+02	1.990E+02			
IY=18	2.011E+02	1.990E+02			
IY=17	2.022E+02	1.990E+02			
IY=16	2.036E+02	1.990E+02			
IY=15	2.054E+02	1.990E+02			
IY=14	2.074E+02	1.990E+02			
IY=13	2.092E+02	1.990E+02			
IY=12	2.106E+02	1.990E+02			
IY=11	2.116E+02	1.990E+02			
IY=10	2.122E+02	1.990E+02			
IY= 9	2.124E+02	1.990E+02			
IY= 8	2.124E+02	1.990E+02			
IY= 7	2.123E+02	1.990E+02			
IY= 6	2.120E+02	1.990E+02			
IY= 5	2.091E+02	1.990E+02			
IY= 4	2.068E+02	1.990E+02			
IY= 3	2.039E+02	1.990E+02			
IY= 2	2.014E+02	1.988E+02			
IY= 1	2.008E+02	1.964E+02			
IZ=	21	22			

FIELD VALUES OF H1

IY=25	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=24	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=23	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=22	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=21	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05

IY=20	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=19	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=18	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=17	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=16	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=15	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=14	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=13	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=12	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=11	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=10	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 9	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 8	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 7	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 6	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 5	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 4	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 3	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 2	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 1	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IZ=	1	2	3	4	5
IY=25	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=24	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=23	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=22	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=21	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=20	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=19	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=18	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=17	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=16	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=15	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=14	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=13	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=12	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05

IY=11	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=10	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 9	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 8	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 7	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 6	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 5	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.149E+05
IY= 4	6.150E+05	6.150E+05	6.150E+05	6.147E+05	6.140E+05
IY= 3	6.150E+05	6.149E+05	6.144E+05	6.113E+05	6.029E+05
IY= 2	6.141E+05	6.099E+05	6.035E+05	5.859E+05	5.793E+05
IY= 1	5.690E+05	5.372E+05	5.194E+05	5.258E+05	5.262E+05
IZ=	6	7	8	9	10
IY=25	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=24	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=23	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=22	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=21	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=20	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=19	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=18	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=17	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=16	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=15	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=14	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=13	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=12	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=11	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=10	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 9	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 8	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 7	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 6	6.150E+05	6.150E+05	6.150E+05	6.149E+05	6.149E+05
IY= 5	6.148E+05	6.145E+05	6.139E+05	6.129E+05	6.123E+05
IY= 4	6.123E+05	6.093E+05	6.048E+05	5.995E+05	5.967E+05
IY= 3	5.935E+05	5.863E+05	5.816E+05	5.785E+05	5.770E+05

IY= 2	5.766E+05	5.734E+05	5.702E+05	5.676E+05	5.663E+05
IY= 1	5.252E+05	5.233E+05	5.211E+05	5.190E+05	5.180E+05
IZ=	11	12	13	14	15
IY=25	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=24	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=23	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=22	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=21	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=20	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=19	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=18	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=17	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=16	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=15	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=14	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=13	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=12	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=11	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY=10	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 9	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 8	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 7	6.150E+05	6.150E+05	6.150E+05	6.150E+05	6.150E+05
IY= 6	6.149E+05	6.149E+05	6.149E+05	6.149E+05	6.147E+05
IY= 5	6.115E+05	6.113E+05	6.111E+05	6.110E+05	6.087E+05
IY= 4	5.941E+05	5.934E+05	5.927E+05	5.921E+05	5.897E+05
IY= 3	5.757E+05	5.754E+05	5.750E+05	5.748E+05	5.733E+05
IY= 2	5.651E+05	5.648E+05	5.645E+05	5.642E+05	5.621E+05
IY= 1	5.170E+05	5.168E+05	5.165E+05	5.172E+05	5.163E+05
IZ=	16	17	18	19	20
IY=25	6.150E+05	6.150E+05			
IY=24	6.150E+05	6.150E+05			
IY=23	6.150E+05	6.150E+05			
IY=22	6.150E+05	6.150E+05			
IY=21	6.150E+05	6.150E+05			
IY=20	6.150E+05	6.150E+05			

IY=19	6.150E+05	6.149E+05
IY=18	6.150E+05	6.148E+05
IY=17	6.150E+05	6.145E+05
IY=16	6.150E+05	6.140E+05
IY=15	6.150E+05	6.131E+05
IY=14	6.150E+05	6.114E+05
IY=13	6.150E+05	6.084E+05
IY=12	6.150E+05	6.031E+05
IY=11	6.150E+05	5.940E+05
IY=10	6.150E+05	5.787E+05
IY= 9	6.150E+05	5.536E+05
IY= 8	6.150E+05	5.131E+05
IY= 7	6.150E+05	4.482E+05
IY= 6	6.144E+05	3.444E+05
IY= 5	6.068E+05	1.758E+05
IY= 4	5.882E+05	1.128E+05
IY= 3	5.728E+05	6.214E+04
IY= 2	5.629E+05	2.723E+04
IY= 1	5.156E+05	7.552E+03
IZ=	21	22

FIELD VALUES OF KE

IY=25	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY=24	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY=23	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY=22	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY=21	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY=20	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY=19	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY=18	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY=17	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY=16	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY=15	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY=14	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY=13	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY=12	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01

IY=11	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY=10	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY= 9	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.870E+01
IY= 8	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.871E+01
IY= 7	7.889E+01	7.885E+01	7.880E+01	7.875E+01	7.886E+01
IY= 6	7.889E+01	7.885E+01	7.880E+01	7.879E+01	8.055E+01
IY= 5	7.889E+01	7.885E+01	7.880E+01	7.883E+01	8.492E+01
IY= 4	7.889E+01	7.885E+01	7.880E+01	7.883E+01	8.691E+01
IY= 3	7.889E+01	7.885E+01	7.880E+01	7.882E+01	8.719E+01
IY= 2	7.889E+01	7.885E+01	7.880E+01	7.880E+01	8.503E+01
IY= 1	7.889E+01	7.885E+01	7.880E+01	7.880E+01	8.402E+01
IZ=	1	2	3	4	5
IY=25	7.865E+01	7.860E+01	7.855E+01	7.845E+01	7.836E+01
IY=24	7.865E+01	7.860E+01	7.855E+01	7.845E+01	7.836E+01
IY=23	7.865E+01	7.860E+01	7.855E+01	7.845E+01	7.836E+01
IY=22	7.865E+01	7.860E+01	7.855E+01	7.845E+01	7.836E+01
IY=21	7.865E+01	7.860E+01	7.855E+01	7.845E+01	7.836E+01
IY=20	7.865E+01	7.860E+01	7.855E+01	7.845E+01	7.836E+01
IY=19	7.865E+01	7.860E+01	7.855E+01	7.845E+01	7.836E+01
IY=18	7.865E+01	7.860E+01	7.855E+01	7.846E+01	7.836E+01
IY=17	7.865E+01	7.860E+01	7.855E+01	7.846E+01	7.836E+01
IY=16	7.865E+01	7.860E+01	7.855E+01	7.846E+01	7.837E+01
IY=15	7.865E+01	7.860E+01	7.855E+01	7.846E+01	7.838E+01
IY=14	7.865E+01	7.860E+01	7.855E+01	7.847E+01	7.842E+01
IY=13	7.865E+01	7.860E+01	7.856E+01	7.849E+01	7.851E+01
IY=12	7.865E+01	7.860E+01	7.856E+01	7.855E+01	7.873E+01
IY=11	7.865E+01	7.861E+01	7.859E+01	7.872E+01	7.922E+01
IY=10	7.865E+01	7.862E+01	7.866E+01	7.916E+01	8.012E+01
IY= 9	7.866E+01	7.867E+01	7.894E+01	8.011E+01	8.142E+01
IY= 8	7.875E+01	7.900E+01	7.982E+01	8.165E+01	8.269E+01
IY= 7	7.944E+01	8.068E+01	8.209E+01	8.339E+01	8.366E+01
IY= 6	8.351E+01	8.557E+01	8.567E+01	8.538E+01	8.508E+01
IY= 5	8.865E+01	8.913E+01	8.855E+01	8.724E+01	8.618E+01
IY= 4	8.969E+01	8.995E+01	8.923E+01	9.391E+01	1.525E+02
IY= 3	8.965E+01	8.778E+01	8.632E+01	4.550E+02	2.055E+03

IY= 2	1.149E+02	2.120E+02	5.527E+02	6.889E+03	1.156E+04
IY= 1	5.230E+03	4.126E+03	3.531E+03	3.667E+03	3.661E+03
IZ=	6	7	8	9	10
IY=25	7.826E+01	7.816E+01	7.807E+01	7.797E+01	7.792E+01
IY=24	7.826E+01	7.816E+01	7.807E+01	7.797E+01	7.793E+01
IY=23	7.826E+01	7.816E+01	7.807E+01	7.797E+01	7.793E+01
IY=22	7.826E+01	7.817E+01	7.807E+01	7.798E+01	7.793E+01
IY=21	7.826E+01	7.817E+01	7.807E+01	7.799E+01	7.794E+01
IY=20	7.826E+01	7.817E+01	7.808E+01	7.800E+01	7.797E+01
IY=19	7.826E+01	7.818E+01	7.810E+01	7.804E+01	7.802E+01
IY=18	7.827E+01	7.819E+01	7.814E+01	7.812E+01	7.813E+01
IY=17	7.828E+01	7.822E+01	7.823E+01	7.829E+01	7.836E+01
IY=16	7.830E+01	7.829E+01	7.840E+01	7.860E+01	7.875E+01
IY=15	7.835E+01	7.843E+01	7.871E+01	7.911E+01	7.937E+01
IY=14	7.847E+01	7.872E+01	7.921E+01	7.982E+01	8.016E+01
IY=13	7.873E+01	7.922E+01	7.989E+01	8.061E+01	8.094E+01
IY=12	7.922E+01	7.996E+01	8.067E+01	8.129E+01	8.151E+01
IY=11	8.005E+01	8.088E+01	8.141E+01	8.176E+01	8.185E+01
IY=10	8.114E+01	8.178E+01	8.203E+01	8.213E+01	8.214E+01
IY= 9	8.222E+01	8.250E+01	8.252E+01	8.248E+01	8.244E+01
IY= 8	8.300E+01	8.301E+01	8.292E+01	8.281E+01	8.275E+01
IY= 7	8.362E+01	8.349E+01	8.331E+01	8.310E+01	8.298E+01
IY= 6	8.472E+01	8.429E+01	8.390E+01	8.370E+01	8.368E+01
IY= 5	8.798E+01	9.988E+01	1.303E+02	1.855E+02	2.212E+02
IY= 4	3.072E+02	6.276E+02	1.115E+03	1.668E+03	1.947E+03
IY= 3	3.954E+03	5.202E+03	5.826E+03	6.103E+03	6.201E+03
IY= 2	1.268E+04	1.281E+04	1.296E+04	1.317E+04	1.328E+04
IY= 1	3.625E+03	3.572E+03	3.513E+03	3.459E+03	3.440E+03
IZ=	11	12	13	14	15
IY=25	7.788E+01	7.786E+01	7.785E+01	7.785E+01	7.800E+01
IY=24	7.788E+01	7.786E+01	7.785E+01	7.785E+01	7.801E+01
IY=23	7.788E+01	7.787E+01	7.786E+01	7.787E+01	7.830E+01
IY=22	7.789E+01	7.788E+01	7.786E+01	7.789E+01	7.868E+01
IY=21	7.790E+01	7.789E+01	7.788E+01	7.793E+01	7.908E+01
IY=20	7.793E+01	7.793E+01	7.792E+01	7.799E+01	7.944E+01

IY=19	7.800E+01	7.800E+01	7.800E+01	7.808E+01	7.978E+01
IY=18	7.815E+01	7.816E+01	7.817E+01	7.827E+01	8.018E+01
IY=17	7.843E+01	7.845E+01	7.848E+01	7.861E+01	8.074E+01
IY=16	7.892E+01	7.896E+01	7.901E+01	7.918E+01	8.158E+01
IY=15	7.964E+01	7.972E+01	7.980E+01	8.001E+01	8.266E+01
IY=14	8.051E+01	8.060E+01	8.069E+01	8.092E+01	8.374E+01
IY=13	8.125E+01	8.133E+01	8.140E+01	8.161E+01	8.438E+01
IY=12	8.169E+01	8.173E+01	8.177E+01	8.193E+01	8.444E+01
IY=11	8.191E+01	8.193E+01	8.194E+01	8.206E+01	8.418E+01
IY=10	8.213E+01	8.212E+01	8.212E+01	8.221E+01	8.389E+01
IY= 9	8.240E+01	8.239E+01	8.238E+01	8.243E+01	8.359E+01
IY= 8	8.268E+01	8.266E+01	8.264E+01	8.264E+01	8.305E+01
IY= 7	8.285E+01	8.281E+01	8.278E+01	8.274E+01	8.311E+01
IY= 6	8.376E+01	8.379E+01	8.380E+01	8.375E+01	9.621E+01
IY= 5	2.651E+02	2.773E+02	2.889E+02	2.954E+02	5.342E+02
IY= 4	2.205E+03	2.272E+03	2.333E+03	2.372E+03	2.743E+03
IY= 3	6.260E+03	6.275E+03	6.282E+03	6.173E+03	6.404E+03
IY= 2	1.336E+04	1.339E+04	1.340E+04	1.280E+04	1.209E+04
IY= 1	3.424E+03	3.432E+03	3.455E+03	3.710E+03	3.812E+03
IZ=	16	17	18	19	20
IY=25	8.118E+01	8.132E+01			
IY=24	8.131E+01	8.267E+01			
IY=23	8.676E+01	8.906E+01			
IY=22	9.366E+01	9.654E+01			
IY=21	1.006E+02	1.036E+02			
IY=20	1.066E+02	1.096E+02			
IY=19	1.114E+02	1.145E+02			
IY=18	1.156E+02	1.189E+02			
IY=17	1.200E+02	1.230E+02			
IY=16	1.249E+02	1.266E+02			
IY=15	1.300E+02	1.288E+02			
IY=14	1.334E+02	1.288E+02			
IY=13	1.331E+02	1.267E+02			
IY=12	1.289E+02	1.245E+02			
IY=11	1.222E+02	1.263E+02			

IY=10	1.149E+02	1.378E+02
IY= 9	1.070E+02	1.686E+02
IY= 8	9.539E+01	2.357E+02
IY= 7	8.569E+01	3.751E+02
IY= 6	1.112E+02	6.565E+02
IY= 5	7.104E+02	1.220E+03
IY= 4	2.858E+03	1.423E+03
IY= 3	6.069E+03	1.409E+03
IY= 2	1.048E+04	1.217E+03
IY= 1	7.140E+02	1.112E+03
IZ=	21	22

FIELD VALUES OF EP

IY=25	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY=24	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY=23	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY=22	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY=21	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY=20	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY=19	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY=18	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY=17	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY=16	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY=15	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY=14	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY=13	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY=12	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY=11	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY=10	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.715E+03
IY= 9	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.716E+03
IY= 8	8.757E+03	8.747E+03	8.736E+03	8.726E+03	8.718E+03
IY= 7	8.757E+03	8.747E+03	8.736E+03	8.727E+03	8.741E+03
IY= 6	8.757E+03	8.747E+03	8.736E+03	8.733E+03	9.080E+03
IY= 5	8.757E+03	8.747E+03	8.737E+03	8.767E+03	1.133E+04
IY= 4	8.757E+03	8.747E+03	8.737E+03	8.797E+03	1.514E+04
IY= 3	8.757E+03	8.747E+03	8.737E+03	8.833E+03	2.691E+04

IY= 2	8.757E+03	8.747E+03	8.737E+03	8.854E+03	7.841E+04
IY= 1	8.757E+03	8.747E+03	8.737E+03	8.858E+03	4.127E+05
IZ=	1	2	3	4	5
IY=25	8.705E+03	8.695E+03	8.684E+03	8.664E+03	8.643E+03
IY=24	8.705E+03	8.695E+03	8.684E+03	8.664E+03	8.643E+03
IY=23	8.705E+03	8.695E+03	8.684E+03	8.664E+03	8.643E+03
IY=22	8.705E+03	8.695E+03	8.684E+03	8.664E+03	8.643E+03
IY=21	8.705E+03	8.695E+03	8.684E+03	8.664E+03	8.643E+03
IY=20	8.705E+03	8.695E+03	8.684E+03	8.664E+03	8.643E+03
IY=19	8.705E+03	8.695E+03	8.684E+03	8.664E+03	8.644E+03
IY=18	8.705E+03	8.695E+03	8.684E+03	8.664E+03	8.644E+03
IY=17	8.705E+03	8.695E+03	8.684E+03	8.664E+03	8.644E+03
IY=16	8.705E+03	8.695E+03	8.684E+03	8.664E+03	8.645E+03
IY=15	8.705E+03	8.695E+03	8.685E+03	8.665E+03	8.647E+03
IY=14	8.705E+03	8.695E+03	8.685E+03	8.666E+03	8.653E+03
IY=13	8.705E+03	8.695E+03	8.685E+03	8.669E+03	8.667E+03
IY=12	8.705E+03	8.695E+03	8.686E+03	8.679E+03	8.701E+03
IY=11	8.705E+03	8.695E+03	8.690E+03	8.705E+03	8.778E+03
IY=10	8.706E+03	8.697E+03	8.702E+03	8.774E+03	8.922E+03
IY= 9	8.707E+03	8.706E+03	8.744E+03	8.926E+03	9.134E+03
IY= 8	8.720E+03	8.756E+03	8.884E+03	9.186E+03	9.390E+03
IY= 7	8.831E+03	9.038E+03	9.289E+03	9.708E+03	1.022E+04
IY= 6	9.706E+03	1.031E+04	1.075E+04	1.436E+04	2.101E+04
IY= 5	1.429E+04	1.807E+04	2.653E+04	1.475E+05	4.333E+05
IY= 4	2.431E+04	3.954E+04	1.337E+05	1.988E+06	6.624E+06
IY= 3	9.252E+04	1.188E+06	3.878E+06	4.208E+07	1.782E+08
IY= 2	2.071E+07	5.621E+07	1.269E+08	1.144E+09	1.777E+09
IY= 1	3.590E+09	2.529E+09	2.014E+09	2.149E+09	2.168E+09
IZ=	6	7	8	9	10
IY=25	8.623E+03	8.602E+03	8.582E+03	8.562E+03	8.552E+03
IY=24	8.623E+03	8.603E+03	8.582E+03	8.562E+03	8.552E+03
IY=23	8.623E+03	8.603E+03	8.582E+03	8.562E+03	8.552E+03
IY=22	8.623E+03	8.603E+03	8.583E+03	8.563E+03	8.553E+03
IY=21	8.623E+03	8.603E+03	8.583E+03	8.564E+03	8.555E+03
IY=20	8.623E+03	8.603E+03	8.584E+03	8.567E+03	8.559E+03

IY=19	8.623E+03	8.604E+03	8.587E+03	8.573E+03	8.567E+03
IY=18	8.624E+03	8.606E+03	8.594E+03	8.585E+03	8.584E+03
IY=17	8.625E+03	8.611E+03	8.607E+03	8.611E+03	8.619E+03
IY=16	8.629E+03	8.622E+03	8.633E+03	8.659E+03	8.680E+03
IY=15	8.637E+03	8.644E+03	8.682E+03	8.739E+03	8.778E+03
IY=14	8.655E+03	8.689E+03	8.760E+03	8.853E+03	8.904E+03
IY=13	8.695E+03	8.767E+03	8.870E+03	8.980E+03	9.031E+03
IY=12	8.773E+03	8.885E+03	8.994E+03	9.088E+03	9.121E+03
IY=11	8.904E+03	9.033E+03	9.113E+03	9.167E+03	9.181E+03
IY=10	9.081E+03	9.182E+03	9.225E+03	9.256E+03	9.267E+03
IY= 9	9.268E+03	9.336E+03	9.397E+03	9.501E+03	9.565E+03
IY= 8	9.537E+03	9.764E+03	1.014E+04	1.073E+04	1.109E+04
IY= 7	1.119E+04	1.279E+04	1.537E+04	1.942E+04	2.190E+04
IY= 6	3.226E+04	5.461E+04	9.536E+04	1.604E+05	1.997E+05
IY= 5	9.357E+05	1.806E+06	3.144E+06	5.035E+06	6.175E+06
IY= 4	1.492E+07	3.013E+07	5.230E+07	7.701E+07	8.955E+07
IY= 3	3.291E+08	4.211E+08	4.649E+08	4.843E+08	4.922E+08
IY= 2	1.845E+09	1.780E+09	1.750E+09	1.758E+09	1.773E+09
IY= 1	2.160E+09	2.138E+09	2.109E+09	2.086E+09	2.087E+09
IZ=	11	12	13	14	15
IY=25	8.542E+03	8.539E+03	8.537E+03	8.535E+03	8.553E+03
IY=24	8.542E+03	8.539E+03	8.537E+03	8.535E+03	8.554E+03
IY=23	8.542E+03	8.540E+03	8.537E+03	8.537E+03	8.593E+03
IY=22	8.543E+03	8.541E+03	8.538E+03	8.540E+03	8.649E+03
IY=21	8.546E+03	8.543E+03	8.541E+03	8.545E+03	8.717E+03
IY=20	8.551E+03	8.548E+03	8.547E+03	8.554E+03	8.788E+03
IY=19	8.561E+03	8.560E+03	8.559E+03	8.569E+03	8.862E+03
IY=18	8.584E+03	8.584E+03	8.585E+03	8.598E+03	8.944E+03
IY=17	8.627E+03	8.630E+03	8.633E+03	8.652E+03	9.052E+03
IY=16	8.704E+03	8.710E+03	8.717E+03	8.742E+03	9.202E+03
IY=15	8.819E+03	8.830E+03	8.841E+03	8.873E+03	9.392E+03
IY=14	8.957E+03	8.971E+03	8.985E+03	9.020E+03	9.571E+03
IY=13	9.078E+03	9.090E+03	9.101E+03	9.131E+03	9.662E+03
IY=12	9.149E+03	9.155E+03	9.161E+03	9.184E+03	9.646E+03
IY=11	9.192E+03	9.194E+03	9.196E+03	9.213E+03	9.592E+03

IY=10	9.281E+03	9.285E+03	9.290E+03	9.306E+03	9.623E+03
IY= 9	9.645E+03	9.668E+03	9.692E+03	9.731E+03	1.010E+04
IY= 8	1.150E+04	1.162E+04	1.175E+04	1.192E+04	1.357E+04
IY= 7	2.488E+04	2.572E+04	2.658E+04	2.769E+04	5.542E+04
IY= 6	2.458E+05	2.584E+05	2.706E+05	2.807E+05	8.856E+05
IY= 5	7.500E+06	7.857E+06	8.174E+06	8.243E+06	2.090E+07
IY= 4	1.011E+08	1.041E+08	1.067E+08	1.076E+08	1.454E+08
IY= 3	4.969E+08	4.984E+08	4.987E+08	4.856E+08	5.439E+08
IY= 2	1.785E+09	1.790E+09	1.794E+09	1.692E+09	1.651E+09
IY= 1	2.085E+09	2.100E+09	2.125E+09	2.368E+09	2.462E+09
IZ=	16	17	18	19	20
IY=25	9.070E+03	9.100E+03			
IY=24	9.091E+03	9.400E+03			
IY=23	1.003E+04	1.086E+04			
IY=22	1.135E+04	1.348E+04			
IY=21	1.289E+04	1.859E+04			
IY=20	1.446E+04	2.946E+04			
IY=19	1.595E+04	5.318E+04			
IY=18	1.731E+04	1.035E+05			
IY=17	1.864E+04	2.[illegible]E+05			
IY=16	2.005E+04	4.036E+05			
IY=15	2.144E+04	7.768E+05			
IY=14	2.225E+04	1.465E+06			
IY=13	2.183E+04	2.723E+06			
IY=12	2.029E+04	5.012E+06			
IY=11	1.834E+04	9.216E+06			
IY=10	1.670E+04	1.711E+07			
IY= 9	1.620E+04	3.248E+07			
IY= 8	2.181E+04	6.375E+07			
IY= 7	1.107E+05	1.303E+08			
IY= 6	1.640E+06	2.789E+08			
IY= 5	3.001E+07	6.337E+08			
IY= 4	1.560E+08	8.500E+08			
IY= 3	4.985E+08	1.083E+09			
IY= 2	1.293E+09	1.309E+09			

IY= 1	1.996E+08	1.758E+09			
IZ=	21	22			

FIELD VALUES OF VRES

IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	2.052E-06	-1.224E-04	-1.195E-04	-6.079E-05	-9.292E-04
IY=23	3.358E-07	6.825E-05	1.895E-04	3.480E-04	1.501E-04
IY=22	-8.184E-06	1.025E-04	2.637E-04	2.522E-04	3.907E-04
IY=21	1.187E-05	7.094E-05	6.387E-05	6.128E-05	5.942E-05
IY=20	1.097E-05	-6.435E-05	-4.912E-05	-5.266E-05	-1.099E-05
IY=19	-2.301E-05	4.384E-06	2.947E-05	6.302E-05	-4.042E-05
IY=18	-6.659E-06	-8.743E-05	-6.123E-05	-5.263E-05	-3.187E-04
IY=17	3.383E-05	6.117E-05	-1.151E-04	-2.470E-04	-5.219E-04
IY=16	-2.302E-05	-1.037E-04	-9.871E-05	-1.298E-04	6.546E-05
IY=15	-6.482E-05	1.465E-05	8.743E-06	1.592E-04	3.456E-04
IY=14	3.515E-05	7.435E-05	6.181E-05	3.146E-05	6.580E-05
IY=13	2.856E-06	1.343E-05	1.237E-04	2.093E-04	6.133E-04
IY=12	3.145E-05	1.130E-04	2.238E-04	5.125E-04	1.591E-03
IY=11	2.904E-06	1.089E-04	1.719E-04	7.715E-04	3.107E-03
IY=10	-2.627E-05	3.378E-05	2.726E-04	1.538E-03	8.676E-03
IY= 9	4.137E-05	-6.509E-05	4.582E-04	4.362E-03	2.560E-02
IY= 8	-3.237E-05	3.282E-04	1.816E-03	1.201E-02	7.600E-02
IY= 7	1.592E-05	3.752E-04	3.623E-03	2.936E-02	2.202E-01
IY= 6	1.608E-04	7.173E-04	6.174E-03	6.201E-02	6.055E-01
IY= 5	3.930E-04	1.353E-03	6.708E-03	8.256E-02	1.356E+00
IY= 4	5.092E-04	1.189E-03	4.613E-03	5.813E-02	1.259E+00
IY= 3	4.218E-04	8.586E-04	2.627E-03	3.353E-02	9.710E-01
IY= 2	3.041E-04	4.422E-04	1.154E-03	1.487E-02	5.511E-01
IY= 1	8.210E-05	1.174E-04	2.967E-04	4.057E-03	1.595E-01
IZ=	1	2	3	4	5
IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	-3.247E-03	-3.952E-03	-2.227E-03	2.613E-03	4.126E-03
IY=23	-4.655E-04	-1.387E-03	-1.980E-03	8.681E-05	4.066E-03
IY=22	2.329E-04	3.420E-06	-2.383E-04	4.747E-04	5.184E-03
IY=21	4.047E-04	5.827E-04	5.886E-04	1.634E-03	9.322E-03
IY=20	-2.146E-04	-1.858E-04	3.750E-06	3.045E-03	1.758E-02

IY=19	-2.367E-04	-5.718E-04	-2.735E-04	5.541E-03	3.258E-02
IY=18	-4.877E-04	-3.759E-04	2.366E-04	1.168E-02	6.151E-02
IY=17	-5.350E-04	-2.207E-04	1.515E-03	2.356E-02	1.175E-01
IY=16	6.400E-05	4.193E-04	3.462E-03	4.610E-02	2.223E-01
IY=15	3.047E-04	1.151E-03	7.800E-03	9.291E-02	4.241E-01
IY=14	8.382E-04	3.248E-03	1.681E-02	1.876E-01	8.105E-01
IY=13	1.834E-03	7.435E-03	3.706E-02	3.837E-01	1.549E+00
IY=12	4.795E-03	1.853E-02	8.433E-02	7.940E-01	2.952E+00
IY=11	1.282E-02	4.978E-02	2.021E-01	1.660E+00	5.564E+00
IY=10	3.679E-02	1.399E-01	5.050E-01	3.487E+00	1.026E+01
IY= 9	1.132E-01	4.136E-01	1.322E+00	7.282E+00	1.815E+01
IY= 8	3.587E-01	1.277E+00	3.592E+00	1.479E+01	2.997E+01
IY= 7	1.197E+00	4.077E+00	9.867E+00	2.809E+01	4.460E+01
IY= 6	4.282E+00	1.312E+01	2.572E+01	4.691E+01	5.744E+01
IY= 5	1.696E+01	3.977E+01	5.607E+01	6.261E+01	6.183E+01
IY= 4	2.920E+01	5.103E+01	6.033E+01	6.276E+01	6.176E+01
IY= 3	4.116E+01	5.798E+01	6.180E+01	6.171E+01	5.954E+01
IY= 2	5.205E+01	6.027E+01	5.991E+01	5.610E+01	5.381E+01
IY= 1	5.081E+01	4.636E+01	4.207E+01	4.195E+01	4.190E+01
IZ=	6	7	8	9	10
IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	6.396E-03	1.690E-02	4.781E-02	1.181E-01	1.683E-01
IY=23	1.264E-02	3.826E-02	1.081E-01	2.643E-01	3.746E-01
IY=22	2.134E-02	7.058E-02	1.995E-01	4.810E-01	6.775E-01
IY=21	3.834E-02	1.253E-01	3.481E-01	8.206E-01	1.148E+00
IY=20	6.926E-02	2.206E-01	5.948E-01	1.366E+00	1.894E+00
IY=19	1.253E-01	3.863E-01	1.007E+00	2.238E+00	3.070E+00
IY=18	2.279E-01	6.751E-01	1.689E+00	3.616E+00	4.894E+00
IY=17	4.144E-01	1.174E+00	2.806E+00	5.745E+00	7.648E+00
IY=16	7.510E-01	2.026E+00	4.596E+00	8.935E+00	1.166E+01
IY=15	1.359E+00	3.461E+00	7.390E+00	1.351E+01	1.720E+01
IY=14	2.442E+00	5.823E+00	1.158E+01	1.971E+01	2.435E+01
IY=13	4.342E+00	9.578E+00	1.754E+01	2.748E+01	3.279E+01
IY=12	7.581E+00	1.525E+01	2.536E+01	3.632E+01	4.164E+01
IY=11	1.285E+01	2.318E+01	3.471E+01	4.508E+01	4.956E+01

IY=10	2.083E+01	3.317E+01	4.443E+01	5.254E+01	5.565E+01
IY= 9	3.162E+01	4.401E+01	5.275E+01	5.779E+01	5.949E+01
IY= 8	4.396E+01	5.346E+01	5.844E+01	6.066E+01	6.128E+01
IY= 7	5.485E+01	5.949E+01	6.116E+01	6.165E+01	6.174E+01
IY= 6	6.084E+01	6.158E+01	6.170E+01	6.174E+01	6.175E+01
IY= 5	6.140E+01	6.156E+01	6.165E+01	6.150E+01	6.137E+01
IY= 4	6.108E+01	6.065E+01	5.991E+01	5.887E+01	5.831E+01
IY= 3	5.736E+01	5.579E+01	5.465E+01	5.383E+01	5.349E+01
IY= 2	5.285E+01	5.228E+01	5.169E+01	5.114E+01	5.089E+01
IY= 1	4.162E+01	4.124E+01	4.080E+01	4.038E+01	4.020E+01
IZ=	11	12	13	14	15
IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	2.365E-01	2.553E-01	2.743E-01	2.940E-01	3.138E-01
IY=23	5.204E-01	5.610E-01	6.016E-01	6.430E-01	6.855E-01
IY=22	9.349E-01	1.007E+00	1.079E+00	1.152E+00	1.229E+00
IY=21	1.573E+00	1.693E+00	1.812E+00	1.934E+00	2.064E+00
IY=20	2.572E+00	2.763E+00	2.955E+00	3.151E+00	3.361E+00
IY=19	4.123E+00	4.421E+00	4.719E+00	5.026E+00	5.358E+00
IY=18	6.484E+00	6.933E+00	7.384E+00	7.846E+00	8.354E+00
IY=17	9.963E+00	1.062E+01	1.127E+01	1.194E+01	1.268E+01
IY=16	1.487E+01	1.577E+01	1.667E+01	1.759E+01	1.861E+01
IY=15	2.138E+01	2.254E+01	2.369E+01	2.486E+01	2.616E+01
IY=14	2.935E+01	3.073E+01	3.208E+01	3.343E+01	3.490E+01
IY=13	3.813E+01	3.956E+01	4.091E+01	4.223E+01	4.361E+01
IY=12	4.642E+01	4.766E+01	4.880E+01	4.989E+01	5.099E+01
IY=11	5.320E+01	5.411E+01	5.493E+01	5.568E+01	5.641E+01
IY=10	5.792E+01	5.847E+01	5.893E+01	5.933E+01	5.971E+01
IY= 9	6.056E+01	6.079E+01	6.098E+01	6.113E+01	6.125E+01
IY= 8	6.158E+01	6.164E+01	6.167E+01	6.170E+01	6.171E+01
IY= 7	6.177E+01	6.177E+01	6.176E+01	6.175E+01	6.173E+01
IY= 6	6.175E+01	6.174E+01	6.172E+01	6.167E+01	6.144E+01
IY= 5	6.120E+01	6.114E+01	6.101E+01	6.060E+01	5.857E+01
IY= 4	5.775E+01	5.757E+01	5.730E+01	5.636E+01	4.991E+01
IY= 3	5.321E+01	5.313E+01	5.298E+01	5.187E+01	3.830E+01
IY= 2	5.069E+01	5.065E+01	5.062E+01	4.999E+01	2.377E+01

IY= 1	4.005E+01	4.005E+01	4.012E+01	4.085E+01	6.385E+00
IZ=	16	17	18	19	20
IY=25	0.000E+00	0.000E+00			
IY=24	3.345E-01	4.164E-01			
IY=23	7.320E-01	9.446E-01			
IY=22	1.317E+00	1.808E+00			
IY=21	2.215E+00	3.229E+00			
IY=20	3.603E+00	5.489E+00			
IY=19	5.713E+00	8.894E+00			
IY=18	8.858E+00	1.369E+01			
IY=17	1.338E+01	1.996E+01			
IY=16	1.953E+01	2.749E+01			
IY=15	2.730E+01	3.568E+01			
IY=14	3.614E+01	4.361E+01			
IY=13	4.475E+01	5.023E+01			
IY=12	5.190E+01	5.484E+01			
IY=11	5.700E+01	5.722E+01			
IY=10	6.001E+01	5.746E+01			
IY= 9	6.135E+01	5.571E+01			
IY= 8	6.172E+01	5.197E+01			
IY= 7	6.167E+01	4.570E+01			
IY= 6	6.103E+01	3.572E+01			
IY= 5	5.525E+01	2.000E+01			
IY= 4	4.176E+01	6.139E+00			
IY= 3	2.483E+01	1.626E+00			
IY= 2	8.676E+00	-4.058E-01			
IY= 1	3.213E-01	-8.948E-01			
IZ=	21	22			

FIELD VALUES OF VCRT

IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	2.052E-06	-1.224E-04	-1.195E-04	-6.079E-05	-9.309E-04
IY=23	3.358E-07	6.825E-05	1.895E-04	3.480E-04	1.468E-04
IY=22	-8.184E-06	1.025E-04	2.637E-04	2.522E-04	3.874E-04
IY=21	1.187E-05	7.094E-05	6.387E-05	6.128E-05	5.611E-05
IY=20	1.097E-05	-6.435E-05	-4.912E-05	-5.266E-05	-1.761E-05

IY=19	-2.301E-05	4.384E-06	2.947E-05	6.302E-05	-5.035E-05
IY=18	-6.659E-06	-8.743E-05	-6.123E-05	-5.263E-05	-3.187E-04
IY=17	3.383E-05	6.117E-05	-1.151E-04	-2.470E-04	-5.219E-04
IY=16	-2.302E-05	-1.037E-04	-9.871E-05	-1.298E-04	6.215E-05
IY=15	-6.482E-05	1.465E-05	8.743E-06	1.592E-04	3.390E-04
IY=14	3.515E-05	7.435E-05	6.181E-05	3.146E-05	5.587E-05
IY=13	2.856E-06	1.343E-05	1.237E-04	2.093E-04	6.001E-04
IY=12	3.145E-05	1.130E-04	2.238E-04	5.125E-04	1.571E-03
IY=11	2.904E-06	1.089E-04	1.719E-04	7.715E-04	3.103E-03
IY=10	-2.627E-05	3.378E-05	2.726E-04	1.538E-03	8.667E-03
IY= 9	4.137E-05	-6.509E-05	4.582E-04	4.362E-03	2.558E-02
IY= 8	-3.237E-05	3.282E-04	1.816E-03	1.201E-02	7.597E-02
IY= 7	1.592E-05	3.752E-04	3.623E-03	2.936E-02	2.202E-01
IY= 6	1.608E-04	7.173E-04	6.174E-03	6.201E-02	6.055E-01
IY= 5	3.930E-04	1.353E-03	6.708E-03	8.256E-02	1.356E+00
IY= 4	5.092E-04	1.189E-03	4.613E-03	5.813E-02	1.259E+00
IY= 3	4.218E-04	8.586E-04	2.627E-03	3.353E-02	9.710E-01
IY= 2	3.041E-04	4.422E-04	1.154E-03	1.487E-02	5.511E-01
IY= 1	8.210E-05	1.174E-04	2.967E-04	4.057E-03	1.595E-01
IZ=	1	2	3	4	5
IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	-3.247E-03	-3.952E-03	-2.227E-03	2.613E-03	4.126E-03
IY=23	-4.655E-04	-1.387E-03	-1.980E-03	8.350E-05	4.063E-03
IY=22	2.296E-04	1.107E-07	-2.416E-04	4.714E-04	5.184E-03
IY=21	3.948E-04	5.728E-04	5.820E-04	1.628E-03	9.316E-03
IY=20	-2.245E-04	-1.991E-04	3.750E-06	3.028E-03	1.757E-02
IY=19	-2.400E-04	-5.784E-04	-2.768E-04	5.538E-03	3.257E-02
IY=18	-4.943E-04	-3.892E-04	2.168E-04	1.167E-02	6.150E-02
IY=17	-5.515E-04	-2.306E-04	1.509E-03	2.355E-02	1.174E-01
IY=16	4.084E-05	3.995E-04	3.445E-03	4.608E-02	2.223E-01
IY=15	2.981E-04	1.144E-03	7.787E-03	9.291E-02	4.241E-01
IY=14	8.117E-04	3.248E-03	1.681E-02	1.876E-01	8.105E-01
IY=13	1.821E-03	7.402E-03	3.704E-02	3.837E-01	1.549E+00
IY=12	4.782E-03	1.852E-02	8.432E-02	7.940E-01	2.952E+00
IY=11	1.280E-02	4.978E-02	2.021E-01	1.660E+00	5.564E+00

IY=10	3.679E-02	1.399E-01	5.049E-01	3.487E+00	1.026E+01
IY= 9	1.132E-01	4.136E-01	1.321E+00	7.282E+00	1.815E+01
IY= 8	3.587E-01	1.277E+00	3.592E+00	1.479E+01	2.997E+01
IY= 7	1.196E+00	4.077E+00	9.867E+00	2.809E+01	4.460E+01
IY= 6	4.282E+00	1.312E+01	2.572E+01	4.691E+01	5.744E+01
IY= 5	1.696E+01	3.977E+01	5.607E+01	6.261E+01	6.183E+01
IY= 4	2.920E+01	5.103E+01	6.033E+01	6.276E+01	6.176E+01
IY= 3	4.116E+01	5.798E+01	6.180E+01	6.171E+01	5.954E+01
IY= 2	5.205E+01	6.027E+01	5.991E+01	5.610E+01	5.381E+01
IY= 1	5.081E+01	4.636E+01	4.207E+01	4.195E+01	4.190E+01
IZ=	6	7	8	9	10
IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	6.396E-03	1.690E-02	4.781E-02	1.181E-01	1.683E-01
IY=23	1.264E-02	3.825E-02	1.081E-01	2.643E-01	3.746E-01
IY=22	2.133E-02	7.058E-02	1.995E-01	4.810E-01	6.775E-01
IY=21	3.833E-02	1.253E-01	3.481E-01	8.206E-01	1.148E+00
IY=20	6.924E-02	2.206E-01	5.948E-01	1.366E+00	1.894E+00
IY=19	1.253E-01	3.863E-01	1.007E+00	2.238E+00	3.070E+00
IY=18	2.279E-01	6.750E-01	1.689E+00	3.616E+00	4.894E+00
IY=17	4.144E-01	1.174E+00	2.806E+00	5.745E+00	7.648E+00
IY=16	7.509E-01	2.026E+00	4.596E+00	8.934E+00	1.166E+01
IY=15	1.359E+00	3.461E+00	7.389E+00	1.351E+01	1.720E+01
IY=14	2.442E+00	5.823E+00	1.158E+01	1.971E+01	2.435E+01
IY=13	4.342E+00	9.578E+00	1.754E+01	2.748E+01	3.279E+01
IY=12	7.581E+00	1.525E+01	2.538E+01	3.632E+01	4.164E+01
IY=11	1.285E+01	2.318E+01	3.471E+01	4.508E+01	4.956E+01
IY=10	2.083E+01	3.317E+01	4.443E+01	5.254E+01	5.565E+01
IY= 9	3.162E+01	4.401E+01	5.275E+01	5.779E+01	5.949E+01
IY= 8	4.396E+01	5.346E+01	5.844E+01	6.066E+01	6.128E+01
IY= 7	5.485E+01	5.949E+01	6.116E+01	6.165E+01	6.174E+01
IY= 6	6.084E+01	6.158E+01	6.170E+01	6.174E+01	6.175E+01
IY= 5	6.140E+01	6.156E+01	6.165E+01	6.150E+01	6.137E+01
IY= 4	6.108E+01	6.065E+01	5.991E+01	5.887E+01	5.831E+01
IY= 3	5.736E+01	5.579E+01	5.465E+01	5.383E+01	5.349E+01
IY= 2	5.285E+01	5.228E+01	5.169E+01	5.114E+01	5.089E+01

IY= 1	4.162E+01	4.124E+01	4.080E+01	4.038E+01	4.020E+01
IZ=	11	12	13	14	15
IY=25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IY=24	2.365E-01	2.553E-01	2.743E-01	2.940E-01	3.138E-01
IY=23	5.204E-01	5.610E-01	6.016E-01	6.430E-01	6.855E-01
IY=22	9.349E-01	1.007E+00	1.079E+00	1.152E+00	1.229E+00
IY=21	1.573E+00	1.693E+00	1.812E+00	1.934E+00	2.064E+00
IY=20	2.572E+00	2.763E+00	2.955E+00	3.151E+00	3.361E+00
IY=19	4.123E+00	4.421E+00	4.719E+00	5.026E+00	5.358E+00
IY=18	6.484E+00	6.933E+00	7.384E+00	7.846E+00	8.354E+00
IY=17	9.963E+00	1.062E+01	1.127E+01	1.194E+01	1.268E+01
IY=16	1.487E+01	1.577E+01	1.667E+01	1.759E+01	1.861E+01
IY=15	2.138E+01	2.254E+01	2.369E+01	2.486E+01	2.616E+01
IY=14	2.935E+01	3.073E+01	3.208E+01	3.343E+01	3.490E+01
IY=13	3.813E+01	3.956E+01	4.091E+01	4.223E+01	4.361E+01
IY=12	4.642E+01	4.766E+01	4.880E+01	4.989E+01	5.099E+01
IY=11	5.320E+01	5.411E+01	5.493E+01	5.568E+01	5.641E+01
IY=10	5.792E+01	5.847E+01	5.893E+01	5.933E+01	5.971E+01
IY= 9	6.056E+01	6.079E+01	6.098E+01	6.113E+01	6.125E+01
IY= 8	6.158E+01	6.164E+01	6.167E+01	6.170E+01	6.171E+01
IY= 7	6.177E+01	6.177E+01	6.176E+01	6.175E+01	6.173E+01
IY= 6	6.175E+01	6.174E+01	6.172E+01	6.167E+01	6.144E+01
IY= 5	6.120E+01	6.114E+01	6.101E+01	6.060E+01	5.857E+01
IY= 4	5.775E+01	5.757E+01	5.730E+01	5.636E+01	4.991E+01
IY= 3	5.321E+01	5.313E+01	5.298E+01	5.187E+01	3.830E+01
IY= 2	5.069E+01	5.065E+01	5.062E+01	4.999E+01	2.377E+01
IY= 1	4.005E+01	4.005E+01	4.012E+01	4.085E+01	6.385E+00
IZ=	16	17	18	19	20
IY=25	0.000E+00	0.000E+00			
IY=24	3.345E-01	4.164E-01			
IY=23	7.321E-01	9.447E-01			
IY=22	1.317E+00	1.809E+00			
IY=21	2.215E+00	3.229E+00			
IY=20	3.603E+00	5.489E+00			
IY=19	5.713E+00	8.894E+00			

IY=18	8.859E+00	1.370E+01
IY=17	1.338E+01	1.996E+01
IY=16	1.953E+01	2.749E+01
IY=15	2.730E+01	3.568E+01
IY=14	3.614E+01	4.361E+01
IY=13	4.475E+01	5.023E+01
IY=12	5.190E+01	5.484E+01
IY=11	5.700E+01	5.722E+01
IY=10	6.001E+01	5.746E+01
IY= 9	6.135E+01	5.571E+01
IY= 8	6.172E+01	5.197E+01
IY= 7	6.167E+01	4.570E+01
IY= 6	6.103E+01	3.572E+01
IY= 5	5.525E+01	2.000E+01
IY= 4	4.176E+01	6.139E+00
IY= 3	2.487E+01	1.626E+00
IY= 2	8.676E+00	-4.055E-01
IY= 1	3.196E-01	-8.963E-01
IZ=	21	22

FIELD VALUES OF WRES

IY=25	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=24	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=23	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=22	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=21	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=20	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=19	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=18	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=17	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=16	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=15	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=14	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.883E+02
IY=13	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.883E+02
IY=12	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.883E+02
IY=11	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.882E+02

IY=10	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.882E+02
IY= 9	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.881E+02
IY= 8	8.885E+02	8.885E+02	8.885E+02	8.884E+02	8.878E+02
IY= 7	8.885E+02	8.885E+02	8.885E+02	8.883E+02	8.871E+02
IY= 6	8.885E+02	8.885E+02	8.884E+02	8.880E+02	8.847E+02
IY= 5	8.885E+02	8.885E+02	8.884E+02	8.875E+02	8.782E+02
IY= 4	8.885E+02	8.885E+02	8.884E+02	8.874E+02	8.749E+02
IY= 3	8.885E+02	8.885E+02	8.884E+02	8.873E+02	8.715E+02
IY= 2	8.885E+02	8.885E+02	8.884E+02	8.873E+02	8.684E+02
IY= 1	8.885E+02	8.885E+02	8.884E+02	8.873E+02	8.666E+02
IZ=	1	2	3	4	5
IY=25	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=24	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=23	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=22	8.884E+02	8.884E+02	8.884E+02	8.884E+02	8.884E+02
IY=21	8.884E+02	8.884E+02	8.884E+02	8.884E+02	8.883E+02
IY=20	8.883E+02	8.883E+02	8.883E+02	8.883E+02	8.883E+02
IY=19	8.883E+02	8.883E+02	8.883E+02	8.882E+02	8.882E+02
IY=18	8.882E+02	8.882E+02	8.882E+02	8.882E+02	8.881E+02
IY=17	8.881E+02	8.881E+02	8.881E+02	8.881E+02	8.879E+02
IY=16	8.880E+02	8.880E+02	8.880E+02	8.879E+02	8.877E+02
IY=15	8.879E+02	8.879E+02	8.879E+02	8.877E+02	8.873E+02
IY=14	8.878E+02	8.878E+02	8.877E+02	8.874E+02	8.867E+02
IY=13	8.877E+02	8.877E+02	8.875E+02	8.869E+02	8.858E+02
IY=12	8.876E+02	8.875E+02	8.871E+02	8.862E+02	8.843E+02
IY=11	8.874E+02	8.873E+02	8.865E+02	8.849E+02	8.820E+02
IY=10	8.872E+02	8.869E+02	8.855E+02	8.827E+02	8.788E+02
IY= 9	8.868E+02	8.862E+02	8.835E+02	8.793E+02	8.747E+02
IY= 8	8.861E+02	8.846E+02	8.798E+02	8.745E+02	8.703E+02
IY= 7	8.841E+02	8.809E+02	8.740E+02	8.693E+02	8.670E+02
IY= 6	8.785E+02	8.731E+02	8.674E+02	8.660E+02	8.658E+02
IY= 5	8.707E+02	8.682E+02	8.676E+02	8.673E+02	8.668E+02
IY= 4	8.675E+02	8.665E+02	8.672E+02	8.665E+02	8.642E+02
IY= 3	8.656E+02	8.649E+02	8.648E+02	8.566E+02	8.339E+02
IY= 2	8.622E+02	8.509E+02	8.347E+02	7.855E+02	7.644E+02

IY= 1	7.369E+02	6.452E+02	5.906E+02	6.019E+02	6.004E+02
IZ=	6	7	8	9	10
IY=25	8.885E+02	8.884E+02	8.884E+02	8.884E+02	8.883E+02
IY=24	8.885E+02	8.884E+02	8.884E+02	8.883E+02	8.883E+02
IY=23	8.884E+02	8.884E+02	8.883E+02	8.882E+02	8.882E+02
IY=22	8.884E+02	8.883E+02	8.882E+02	8.881E+02	8.880E+02
IY=21	8.883E+02	8.882E+02	8.880E+02	8.879E+02	8.877E+02
IY=20	8.882E+02	8.880E+02	8.877E+02	8.875E+02	8.873E+02
IY=19	8.881E+02	8.878E+02	8.873E+02	8.870E+02	8.867E+02
IY=18	8.879E+02	8.875E+02	8.867E+02	8.863E+02	8.857E+02
IY=17	8.876E+02	8.869E+02	8.858E+02	8.852E+02	8.844E+02
IY=16	8.871E+02	8.861E+02	8.845E+02	8.836E+02	8.826E+02
IY=15	8.864E+02	8.849E+02	8.827E+02	8.815E+02	8.802E+02
IY=14	8.853E+02	8.832E+02	8.804E+02	8.788E+02	8.773E+02
IY=13	8.837E+02	8.808E+02	8.775E+02	8.758E+02	8.743E+02
IY=12	8.814E+02	8.778E+02	8.743E+02	8.727E+02	8.715E+02
IY=11	8.783E+02	8.744E+02	8.714E+02	8.702E+02	8.694E+02
IY=10	8.746E+02	8.711E+02	8.690E+02	8.684E+02	8.681E+02
IY= 9	8.708E+02	8.685E+02	8.674E+02	8.673E+02	8.674E+02
IY= 8	8.679E+02	8.669E+02	8.666E+02	8.668E+02	8.671E+02
IY= 7	8.663E+02	8.662E+02	8.663E+02	8.665E+02	8.668E+02
IY= 6	8.659E+02	8.659E+02	8.660E+02	8.662E+02	8.665E+02
IY= 5	8.664E+02	8.656E+02	8.643E+02	8.620E+02	8.609E+02
IY= 4	8.599E+02	8.520E+02	8.401E+02	8.261E+02	8.191E+02
IY= 3	8.075E+02	7.867E+02	7.729E+02	7.638E+02	7.601E+02
IY= 2	7.557E+02	7.466E+02	7.376E+02	7.301E+02	7.270E+02
IY= 1	5.964E+02	5.907E+02	5.842E+02	5.782E+02	5.756E+02
IZ=	11	12	13	14	15
IY=25	8.883E+02	8.883E+02	8.883E+02	8.883E+02	8.883E+02
IY=24	8.883E+02	8.883E+02	8.883E+02	8.883E+02	8.883E+02
IY=23	8.882E+02	8.882E+02	8.882E+02	8.882E+02	8.882E+02
IY=22	8.880E+02	8.880E+02	8.880E+02	8.880E+02	8.881E+02
IY=21	8.877E+02	8.877E+02	8.877E+02	8.878E+02	8.879E+02
IY=20	8.873E+02	8.873E+02	8.872E+02	8.874E+02	8.876E+02
IY=19	8.866E+02	8.866E+02	8.866E+02	8.867E+02	8.870E+02

IY=18	8.857E+02	8.856E+02	8.856E+02	8.858E+02	8.862E+02
IY=17	8.843E+02	8.842E+02	8.842E+02	8.844E+02	8.850E+02
IY=16	8.824E+02	8.823E+02	8.822E+02	8.824E+02	8.833E+02
IY=15	8.800E+02	8.798E+02	8.798E+02	8.800E+02	8.811E+02
IY=14	8.771E+02	8.769E+02	8.769E+02	8.771E+02	8.785E+02
IY=13	8.741E+02	8.740E+02	8.741E+02	8.744E+02	8.760E+02
IY=12	8.715E+02	8.716E+02	8.718E+02	8.722E+02	8.740E+02
IY=11	8.696E+02	8.698E+02	8.703E+02	8.706E+02	8.725E+02
IY=10	8.684E+02	8.688E+02	8.694E+02	8.698E+02	8.716E+02
IY= 9	8.678E+02	8.683E+02	8.690E+02	8.694E+02	8.711E+02
IY= 8	8.675E+02	8.680E+02	8.687E+02	8.691E+02	8.706E+02
IY= 7	8.673E+02	8.678E+02	8.684E+02	8.688E+02	8.699E+02
IY= 6	8.668E+02	8.673E+02	8.680E+02	8.686E+02	8.694E+02
IY= 5	8.596E+02	8.597E+02	8.604E+02	8.624E+02	8.595E+02
IY= 4	8.125E+02	8.115E+02	8.113E+02	8.143E+02	8.120E+02
IY= 3	7.571E+02	7.571E+02	7.584E+02	7.665E+02	7.668E+02
IY= 2	7.244E+02	7.245E+02	7.261E+02	7.389E+02	7.343E+02
IY= 1	5.735E+02	5.737E+02	5.754E+02	5.976E+02	5.928E+02

IZ=	16	17	18	19	20
IY=25	8.870E+02				
IY=24	8.759E+02				
IY=23	8.547E+02				
IY=22	8.257E+02				
IY=21	7.909E+02				
IY=20	7.527E+02				
IY=19	7.128E+02				
IY=18	6.724E+02				
IY=17	6.320E+02				
IY=16	5.919E+02				
IY=15	5.523E+02				
IY=14	5.137E+02				
IY=13	4.769E+02				
IY=12	4.433E+02				
IY=11	4.134E+02				
IY=10	3.873E+02				

IY= 9	3.646E+02				
IY= 8	3.444E+02				
IY= 7	3.262E+02				
IY= 6	3.093E+02				
IY= 5	2.961E+02				
IY= 4	2.817E+02				
IY= 3	2.720E+02				
IY= 2	2.691E+02				
IY= 1	2.285E+02				
IZ=	21				

FIELD VALUES OF WCRT

IY=25	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=24	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=23	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=22	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=21	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=20	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=19	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=18	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=17	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=16	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=15	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=14	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=13	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=12	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=11	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=10	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY= 9	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY= 8	8.885E+02	8.885E+02	8.885E+02	8.884E+02	8.882E+02
IY= 7	8.885E+02	8.885E+02	8.885E+02	8.883E+02	8.876E+02
IY= 6	8.885E+02	8.885E+02	8.884E+02	8.880E+02	8.851E+02
IY= 5	8.885E+02	8.885E+02	8.884E+02	8.875E+02	8.787E+02
IY= 4	8.885E+02	8.885E+02	8.884E+02	8.874E+02	8.753E+02
IY= 3	8.885E+02	8.885E+02	8.884E+02	8.873E+02	8.720E+02
IY= 2	8.885E+02	8.885E+02	8.884E+02	8.873E+02	8.689E+02

IY= 1	8.885E+02	8.885E+02	8.884E+02	8.873E+02	8.671E+02
IZ=	1	2	3	4	5
IY=25	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=24	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=23	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=22	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=21	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.885E+02
IY=20	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=19	8.885E+02	8.885E+02	8.885E+02	8.885E+02	8.884E+02
IY=18	8.885E+02	8.885E+02	8.885E+02	8.884E+02	8.884E+02
IY=17	8.885E+02	8.885E+02	8.885E+02	8.884E+02	8.883E+02
IY=16	8.885E+02	8.885E+02	8.885E+02	8.884E+02	8.881E+02
IY=15	8.885E+02	8.885E+02	8.884E+02	8.883E+02	8.878E+02
IY=14	8.885E+02	8.885E+02	8.884E+02	8.881E+02	8.873E+02
IY=13	8.885E+02	8.885E+02	8.883E+02	8.877E+02	8.865E+02
IY=12	8.885E+02	8.884E+02	8.881E+02	8.871E+02	8.851E+02
IY=11	8.885E+02	8.883E+02	8.876E+02	8.859E+02	8.828E+02
IY=10	8.884E+02	8.881E+02	8.867E+02	8.837E+02	8.795E+02
IY= 9	8.882E+02	8.875E+02	8.848E+02	8.803E+02	8.750E+02
IY= 8	8.876E+02	8.861E+02	8.812E+02	8.752E+02	8.700E+02
IY= 7	8.858E+02	8.824E+02	8.751E+02	8.692E+02	8.659E+02
IY= 6	8.801E+02	8.741E+02	8.676E+02	8.647E+02	8.639E+02
IY= 5	8.716E+02	8.675E+02	8.658E+02	8.650E+02	8.646E+02
IY= 4	8.676E+02	8.651E+02	8.651E+02	8.642E+02	8.620E+02
IY= 3	8.648E+02	8.630E+02	8.626E+02	8.544E+02	8.318E+02
IY= 2	8.606E+02	8.488E+02	8.325E+02	7.835E+02	7.625E+02
IY= 1	7.352E+02	6.436E+02	5.891E+02	6.004E+02	5.990E+02
IZ=	6	7	8	9	10
IY=25	8.885E+02	8.884E+02	8.884E+02	8.884E+02	8.883E+02
IY=24	8.885E+02	8.884E+02	8.884E+02	8.883E+02	8.883E+02
IY=23	8.885E+02	8.884E+02	8.883E+02	8.883E+02	8.882E+02
IY=22	8.884E+02	8.884E+02	8.882E+02	8.882E+02	8.881E+02
IY=21	8.884E+02	8.883E+02	8.881E+02	8.880E+02	8.878E+02
IY=20	8.884E+02	8.882E+02	8.879E+02	8.877E+02	8.874E+02
IY=19	8.883E+02	8.880E+02	8.875E+02	8.872E+02	8.868E+02

IY=18	8.882E+02	8.877E+02	8.870E+02	8.865E+02	8.859E+02
IY=17	8.879E+02	8.872E+02	8.861E+02	8.854E+02	8.845E+02
IY=16	8.876E+02	8.865E+02	8.849E+02	8.838E+02	8.826E+02
IY=15	8.869E+02	8.853E+02	8.830E+02	8.816E+02	8.801E+02
IY=14	8.859E+02	8.836E+02	8.806E+02	8.787E+02	8.770E+02
IY=13	8.843E+02	8.812E+02	8.775E+02	8.754E+02	8.737E+02
IY=12	8.820E+02	8.780E+02	8.741E+02	8.720E+02	8.705E+02
IY=11	8.787E+02	8.743E+02	8.707E+02	8.690E+02	8.681E+02
IY=10	8.747E+02	8.706E+02	8.678E+02	8.668E+02	8.664E+02
IY= 9	8.704E+02	8.674E+02	8.658E+02	8.654E+02	8.654E+02
IY= 8	8.668E+02	8.652E+02	8.647E+02	8.647E+02	8.650E+02
IY= 7	8.646E+02	8.642E+02	8.642E+02	8.644E+02	8.647E+02
IY= 6	8.637E+02	8.637E+02	8.638E+02	8.640E+02	8.643E+02
IY= 5	8.642E+02	8.635E+02	8.621E+02	8.598E+02	8.587E+02
IY= 4	8.577E+02	8.498E+02	8.380E+02	8.240E+02	8.171E+02
IY= 3	8.054E+02	7.847E+02	7.710E+02	7.619E+02	7.583E+02
IY= 2	7.539E+02	7.448E+02	7.358E+02	7.283E+02	7.252E+02
IY= 1	5.950E+02	5.893E+02	5.828E+02	5.768E+02	5.742E+02
IZ=	11	12	13	14	15
IY=25	8.883E+02	8.883E+02	8.883E+02	8.883E+02	8.883E+02
IY=24	8.883E+02	8.883E+02	8.883E+02	8.883E+02	8.883E+02
IY=23	8.882E+02	8.882E+02	8.882E+02	8.882E+02	8.882E+02
IY=22	8.880E+02	8.880E+02	8.880E+02	8.880E+02	8.881E+02
IY=21	8.878E+02	8.878E+02	8.878E+02	8.878E+02	8.879E+02
IY=20	8.874E+02	8.874E+02	8.873E+02	8.874E+02	8.876E+02
IY=19	8.868E+02	8.867E+02	8.867E+02	8.867E+02	8.870E+02
IY=18	8.858E+02	8.857E+02	8.857E+02	8.857E+02	8.862E+02
IY=17	8.844E+02	8.843E+02	8.842E+02	8.843E+02	8.850E+02
IY=16	8.824E+02	8.822E+02	8.821E+02	8.823E+02	8.833E+02
IY=15	8.798E+02	8.796E+02	8.795E+02	8.797E+02	8.811E+02
IY=14	8.766E+02	8.764E+02	8.763E+02	8.767E+02	8.785E+02
IY=13	8.733E+02	8.731E+02	8.732E+02	8.737E+02	8.760E+02
IY=12	8.703E+02	8.703E+02	8.705E+02	8.712E+02	8.740E+02
IY=11	8.680E+02	8.682E+02	8.686E+02	8.695E+02	8.725E+02
IY=10	8.666E+02	8.669E+02	8.675E+02	8.685E+02	8.716E+02

IY= 9	8.658E+02	8.662E+02	8.669E+02	8.680E+02	8.711E+02
IY= 8	8.654E+02	8.659E+02	8.666E+02	8.677E+02	8.706E+02
IY= 7	8.651E+02	8.656E+02	8.663E+02	8.673E+02	8.699E+02
IY= 6	8.647E+02	8.651E+02	8.658E+02	8.670E+02	8.694E+02
IY= 5	8.574E+02	8.576E+02	8.582E+02	8.608E+02	8.595E+02
IY= 4	8.105E+02	8.094E+02	8.093E+02	8.128E+02	8.120E+02
IY= 3	7.553E+02	7.553E+02	7.565E+02	7.652E+02	7.668E+02
IY= 2	7.226E+02	7.228E+02	7.243E+02	7.376E+02	7.343E+02
IY= 1	5.721E+02	5.723E+02	5.740E+02	5.965E+02	5.928E+02

IZ=	16	17	18	19	20
IY=25	8.884E+02				
IY=24	8.884E+02				
IY=23	8.885E+02				
IY=22	8.885E+02				
IY=21	8.886E+02				
IY=20	8.887E+02				
IY=19	8.889E+02				
IY=18	8.892E+02				
IY=17	8.894E+02				
IY=16	8.897E+02				
IY=15	8.898E+02				
IY=14	8.897E+02				
IY=13	8.891E+02				
IY=12	8.883E+02				
IY=11	8.875E+02				
IY=10	8.869E+02				
IY= 9	8.863E+02				
IY= 8	8.859E+02				
IY= 7	8.854E+02				
IY= 6	8.836E+02				
IY= 5	8.616E+02				
IY= 4	8.021E+02				
IY= 3	7.437E+02				
IY= 2	7.020E+02				
IY= 1	5.809E+02				

IZ= 21

FIELD VALUES OF P1

IY=25	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=24	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=23	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=22	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=21	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=20	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=19	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=18	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=17	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=16	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=15	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=14	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=13	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=12	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=11	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=10	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY= 9	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY= 8	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.049E+05
IY= 7	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.051E+05
IY= 6	1.048E+05	1.048E+05	1.048E+05	1.049E+05	1.056E+05
IY= 5	1.048E+05	1.048E+05	1.048E+05	1.049E+05	1.063E+05
IY= 4	1.048E+05	1.048E+05	1.048E+05	1.049E+05	1.065E+05
IY= 3	1.048E+05	1.048E+05	1.048E+05	1.050E+05	1.066E+05
IY= 2	1.048E+05	1.048E+05	1.048E+05	1.050E+05	1.066E+05
IY= 1	1.048E+05	1.048E+05	1.048E+05	1.049E+05	1.066E+05
IZ=	1	2	3	4	5
IY=25	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=24	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=23	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=22	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=21	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=20	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05
IY=19	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.048E+05

IY=18	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.049E+05
IY=17	1.048E+05	1.048E+05	1.048E+05	1.048E+05	1.049E+05
IY=16	1.048E+05	1.048E+05	1.048E+05	1.049E+05	1.050E+05
IY=15	1.048E+05	1.048E+05	1.048E+05	1.049E+05	1.052E+05
IY=14	1.048E+05	1.048E+05	1.048E+05	1.050E+05	1.055E+05
IY=13	1.048E+05	1.048E+05	1.049E+05	1.052E+05	1.061E+05
IY=12	1.048E+05	1.048E+05	1.049E+05	1.055E+05	1.072E+05
IY=11	1.048E+05	1.049E+05	1.051E+05	1.063E+05	1.092E+05
IY=10	1.049E+05	1.050E+05	1.054E+05	1.078E+05	1.127E+05
IY= 9	1.049E+05	1.053E+05	1.063E+05	1.109E+05	1.184E+05
IY= 8	1.052E+05	1.062E+05	1.086E+05	1.168E+05	1.267E+05
IY= 7	1.062E+05	1.090E+05	1.145E+05	1.268E+05	1.362E+05
IY= 6	1.096E+05	1.179E+05	1.281E+05	1.394E+05	1.427E+05
IY= 5	1.199E+05	1.346E+05	1.413E+05	1.421E+05	1.425E+05
IY= 4	1.267E+05	1.404E+05	1.437E+05	1.425E+05	1.424E+05
IY= 3	1.343E+05	1.438E+05	1.445E+05	1.425E+05	1.423E+05
IY= 2	1.403E+05	1.449E+05	1.446E+05	1.424E+05	1.424E+05
IY= 1	1.429E+05	1.446E+05	1.443E+05	1.423E+05	1.421E+05
IZ=	6	7	8	9	10
IY=25	1.048E+05	1.048E+05	1.049E+05	1.049E+05	1.050E+05
IY=24	1.048E+05	1.048E+05	1.049E+05	1.050E+05	1.050E+05
IY=23	1.048E+05	1.048E+05	1.049E+05	1.050E+05	1.051E+05
IY=22	1.048E+05	1.049E+05	1.050E+05	1.052E+05	1.053E+05
IY=21	1.048E+05	1.049E+05	1.051E+05	1.054E+05	1.056E+05
IY=20	1.049E+05	1.050E+05	1.052E+05	1.057E+05	1.061E+05
IY=19	1.049E+05	1.051E+05	1.055E+05	1.063E+05	1.069E+05
IY=18	1.050E+05	1.053E+05	1.060E+05	1.072E+05	1.081E+05
IY=17	1.051E+05	1.057E+05	1.068E+05	1.087E+05	1.099E+05
IY=16	1.054E+05	1.063E+05	1.081E+05	1.108E+05	1.125E+05
IY=15	1.059E+05	1.073E+05	1.100E+05	1.138E+05	1.161E+05
IY=14	1.067E+05	1.090E+05	1.129E+05	1.179E+05	1.208E+05
IY=13	1.081E+05	1.117E+05	1.169E+05	1.229E+05	1.262E+05
IY=12	1.104E+05	1.156E+05	1.221E+05	1.286E+05	1.317E+05
IY=11	1.142E+05	1.210E+05	1.282E+05	1.340E+05	1.364E+05
IY=10	1.198E+05	1.276E+05	1.342E+05	1.384E+05	1.399E+05

IY= 9	1.271E+05	1.344E+05	1.390E+05	1.413E+05	1.418E+05
IY= 8	1.349E+05	1.398E+05	1.420E+05	1.426E+05	1.426E+05
IY= 7	1.410E+05	1.426E+05	1.430E+05	1.429E+05	1.427E+05
IY= 6	1.432E+05	1.431E+05	1.431E+05	1.430E+05	1.427E+05
IY= 5	1.430E+05	1.432E+05	1.431E+05	1.429E+05	1.427E+05
IY= 4	1.430E+05	1.432E+05	1.431E+05	1.429E+05	1.426E+05
IY= 3	1.429E+05	1.432E+05	1.431E+05	1.429E+05	1.426E+05
IY= 2	1.430E+05	1.434E+05	1.434E+05	1.432E+05	1.429E+05
IY= 1	1.427E+05	1.430E+05	1.430E+05	1.427E+05	1.425E+05
IZ=	11	12	13	14	15
IY=25	1.050E+05	1.050E+05	1.050E+05	1.050E+05	1.050E+05
IY=24	1.051E+05	1.051E+05	1.051E+05	1.051E+05	1.051E+05
IY=23	1.052E+05	1.052E+05	1.052E+05	1.053E+05	1.052E+05
IY=22	1.055E+05	1.055E+05	1.055E+05	1.055E+05	1.055E+05
IY=21	1.059E+05	1.059E+05	1.059E+05	1.060E+05	1.060E+05
IY=20	1.065E+05	1.066E+05	1.066E+05	1.067E+05	1.067E+05
IY=19	1.075E+05	1.076E+05	1.077E+05	1.078E+05	1.078E+05
IY=18	1.090E+05	1.092E+05	1.094E+05	1.095E+05	1.095E+05
IY=17	1.112E+05	1.115E+05	1.118E+05	1.120E+05	1.120E+05
IY=16	1.144E+05	1.148E+05	1.151E+05	1.154E+05	1.155E+05
IY=15	1.186E+05	1.191E+05	1.195E+05	1.198E+05	1.199E+05
IY=14	1.237E+05	1.243E+05	1.247E+05	1.250E+05	1.249E+05
IY=13	1.291E+05	1.297E+05	1.300E+05	1.301E+05	1.297E+05
IY=12	1.341E+05	1.345E+05	1.346E+05	1.345E+05	1.338E+05
IY=11	1.381E+05	1.382E+05	1.381E+05	1.376E+05	1.366E+05
IY=10	1.406E+05	1.405E+05	1.401E+05	1.394E+05	1.382E+05
IY= 9	1.419E+05	1.415E+05	1.410E+05	1.402E+05	1.388E+05
IY= 8	1.423E+05	1.419E+05	1.412E+05	1.403E+05	1.389E+05
IY= 7	1.424E+05	1.419E+05	1.412E+05	1.403E+05	1.389E+05
IY= 6	1.424E+05	1.419E+05	1.412E+05	1.402E+05	1.384E+05
IY= 5	1.423E+05	1.417E+05	1.409E+05	1.392E+05	1.343E+05
IY= 4	1.422E+05	1.416E+05	1.407E+05	1.385E+05	1.303E+05
IY= 3	1.422E+05	1.416E+05	1.407E+05	1.379E+05	1.237E+05
IY= 2	1.425E+05	1.419E+05	1.409E+05	1.379E+05	1.145E+05
IY= 1	1.421E+05	1.415E+05	1.405E+05	1.377E+05	1.080E+05

IZ=	16	17	18	19	20
IY=25	1.050E+05	1.049E+05			
IY=24	1.051E+05	1.049E+05			
IY=23	1.052E+05	1.049E+05			
IY=22	1.055E+05	1.049E+05			
IY=21	1.059E+05	1.049E+05			
IY=20	1.065E+05	1.049E+05			
IY=19	1.076E+05	1.049E+05			
IY=18	1.091E+05	1.049E+05			
IY=17	1.114E+05	1.049E+05			
IY=16	1.145E+05	1.049E+05			
IY=15	1.185E+05	1.049E+05			
IY=14	1.229E+05	1.049E+05			
IY=13	1.271E+05	1.049E+05			
IY=12	1.305E+05	1.049E+05			
IY=11	1.329E+05	1.049E+05			
IY=10	1.342E+05	1.049E+05			
IY= 9	1.347E+05	1.049E+05			
IY= 8	1.348E+05	1.049E+05			
IY= 7	1.347E+05	1.049E+05			
IY= 6	1.338E+05	1.049E+05			
IY= 5	1.268E+05	1.049E+05			
IY= 4	1.217E+05	1.049E+05			
IY= 3	1.151E+05	1.049E+05			
IY= 2	1.098E+05	1.045E+05			
IY= 1	1.087E+05	9.975E+04			
IZ=	21	22			

FIELD VALUES OF PP (density)

IY=25	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=24	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=23	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=22	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=21	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=20	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=19	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00

IY=18	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=17	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=16	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=15	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=14	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=13	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=12	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=11	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=10	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY= 9	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.836E+00
IY= 8	1.835E+00	1.835E+00	1.835E+00	1.836E+00	1.836E+00
IY= 7	1.835E+00	1.835E+00	1.835E+00	1.836E+00	1.839E+00
IY= 6	1.835E+00	1.835E+00	1.835E+00	1.836E+00	1.845E+00
IY= 5	1.835E+00	1.835E+00	1.836E+00	1.837E+00	1.854E+00
IY= 4	1.835E+00	1.835E+00	1.836E+00	1.837E+00	1.857E+00
IY= 3	1.835E+00	1.835E+00	1.836E+00	1.837E+00	1.858E+00
IY= 2	1.835E+00	1.835E+00	1.836E+00	1.837E+00	1.859E+00
IY= 1	1.835E+00	1.835E+00	1.836E+00	1.837E+00	1.859E+00
IZ=	1	2	3	4	5
IY=25	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=24	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=23	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=22	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=21	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.835E+00
IY=20	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.836E+00
IY=19	1.835E+00	1.835E+00	1.835E+00	1.835E+00	1.836E+00
IY=18	1.835E+00	1.835E+00	1.835E+00	1.836E+00	1.836E+00
IY=17	1.835E+00	1.835E+00	1.835E+00	1.836E+00	1.837E+00
IY=16	1.835E+00	1.835E+00	1.835E+00	1.836E+00	1.838E+00
IY=15	1.835E+00	1.835E+00	1.836E+00	1.836E+00	1.840E+00
IY=14	1.835E+00	1.835E+00	1.836E+00	1.838E+00	1.844E+00
IY=13	1.835E+00	1.835E+00	1.836E+00	1.840E+00	1.852E+00
IY=12	1.835E+00	1.836E+00	1.837E+00	1.844E+00	1.866E+00
IY=11	1.836E+00	1.836E+00	1.839E+00	1.854E+00	1.891E+00
IY=10	1.836E+00	1.837E+00	1.843E+00	1.874E+00	1.936E+00

IY= 9	1.837E+00	1.841E+00	1.854E+00	1.914E+00	2.009E+00
IY= 8	1.841E+00	1.853E+00	1.884E+00	1.989E+00	2.112E+00
IY= 7	1.853E+00	1.890E+00	1.959E+00	2.113E+00	2.229E+00
IY= 6	1.897E+00	2.002E+00	2.130E+00	2.267E+00	2.307E+00
IY= 5	2.028E+00	2.209E+00	2.290E+00	2.300E+00	2.305E+00
IY= 4	2.112E+00	2.279E+00	2.319E+00	2.304E+00	2.303E+00
IY= 3	2.205E+00	2.320E+00	2.328E+00	2.304E+00	2.302E+00
IY= 2	2.277E+00	2.333E+00	2.329E+00	2.303E+00	2.303E+00
IY= 1	2.309E+00	2.329E+00	2.325E+00	2.301E+00	2.300E+00
IZ=	6	7	8	9	10
IY=25	1.835E+00	1.836E+00	1.836E+00	1.837E+00	1.838E+00
IY=24	1.835E+00	1.836E+00	1.836E+00	1.837E+00	1.838E+00
IY=23	1.836E+00	1.836E+00	1.837E+00	1.838E+00	1.839E+00
IY=22	1.836E+00	1.836E+00	1.837E+00	1.840E+00	1.842E+00
IY=21	1.836E+00	1.837E+00	1.839E+00	1.843E+00	1.846E+00
IY=20	1.836E+00	1.838E+00	1.841E+00	1.847E+00	1.852E+00
IY=19	1.837E+00	1.839E+00	1.845E+00	1.855E+00	1.862E+00
IY=18	1.838E+00	1.842E+00	1.851E+00	1.867E+00	1.877E+00
IY=17	1.840E+00	1.847E+00	1.861E+00	1.885E+00	1.901E+00
IY=16	1.843E+00	1.855E+00	1.877E+00	1.912E+00	1.934E+00
IY=15	1.849E+00	1.868E+00	1.903E+00	1.951E+00	1.980E+00
IY=14	1.859E+00	1.890E+00	1.939E+00	2.002E+00	2.039E+00
IY=13	1.878E+00	1.924E+00	1.990E+00	2.065E+00	2.106E+00
IY=12	1.908E+00	1.974E+00	2.055E+00	2.135E+00	2.173E+00
IY=11	1.956E+00	2.041E+00	2.130E+00	2.202E+00	2.231E+00
IY=10	2.026E+00	2.123E+00	2.204E+00	2.255E+00	2.273E+00
IY= 9	2.117E+00	2.206E+00	2.262E+00	2.290E+00	2.296E+00
IY= 8	2.213E+00	2.272E+00	2.298E+00	2.306E+00	2.305E+00
IY= 7	2.286E+00	2.306E+00	2.310E+00	2.310E+00	2.307E+00
IY= 6	2.312E+00	2.312E+00	2.312E+00	2.310E+00	2.307E+00
IY= 5	2.310E+00	2.313E+00	2.312E+00	2.310E+00	2.306E+00
IY= 4	2.310E+00	2.312E+00	2.312E+00	2.309E+00	2.306E+00
IY= 3	2.309E+00	2.312E+00	2.311E+00	2.309E+00	2.306E+00
IY= 2	2.311E+00	2.315E+00	2.315E+00	2.312E+00	2.309E+00
IY= 1	2.307E+00	2.310E+00	2.310E+00	2.307E+00	2.304E+00

IZ=	11	12	13	14	15
IY=25	1.838E+00	1.838E+00	1.838E+00	1.838E+00	1.838E+00
IY=24	1.839E+00	1.839E+00	1.839E+00	1.839E+00	1.839E+00
IY=23	1.841E+00	1.841E+00	1.841E+00	1.841E+00	1.841E+00
IY=22	1.844E+00	1.844E+00	1.844E+00	1.844E+00	1.844E+00
IY=21	1.849E+00	1.849E+00	1.850E+00	1.850E+00	1.850E+00
IY=20	1.857E+00	1.858E+00	1.859E+00	1.859E+00	1.860E+00
IY=19	1.870E+00	1.871E+00	1.873E+00	1.874E+00	1.874E+00
IY=18	1.889E+00	1.892E+00	1.894E+00	1.895E+00	1.896E+00
IY=17	1.918E+00	1.922E+00	1.925E+00	1.927E+00	1.928E+00
IY=16	1.958E+00	1.963E+00	1.968E+00	1.971E+00	1.972E+00
IY=15	2.011E+00	2.017E+30	2.023E+00	2.027E+00	2.027E+00
IY=14	2.075E+00	2.082E+00	2.088E+00	2.091E+00	2.090E+00
IY=13	2.142E+00	2.149E+00	2.153E+00	2.154E+00	2.150E+00
IY=12	2.203E+00	2.208E+00	2.209E+00	2.208E+00	2.199E+00
IY=11	2.251E+00	2.252E+00	2.251E+00	2.246E+00	2.233E+00
IY=10	2.282E+00	2.280E+00	2.275E+00	2.268E+00	2.252E+00
IY= 9	2.297E+00	2.293E+00	2.286E+00	2.276E+00	2.259E+00
IY= 8	2.302E+00	2.297E+00	2.289E+00	2.278E+00	2.261E+00
IY= 7	2.303E+00	2.297E+00	2.289E+00	2.278E+00	2.261E+00
IY= 6	2.303E+00	2.297E+00	2.288E+00	2.277E+00	2.255E+00
IY= 5	2.302E+00	2.295E+00	2.285E+00	2.265E+00	2.205E+00
IY= 4	2.301E+00	2.294E+00	2.283E+00	2.256E+00	2.156E+00
IY= 3	2.301E+00	2.294E+00	2.282E+00	2.249E+00	2.074E+00
IY= 2	2.304E+00	2.297E+00	2.286E+00	2.250E+00	1.959E+00
IY= 1	2.299E+00	2.292E+00	2.281E+00	2.247E+00	1.876E+00
IZ=	16	17	18	19	20
IY=25	1.838E+00	1.837E+00			
IY=24	1.839E+00	1.837E+00			
IY=23	1.841E+00	1.837E+00			
IY=22	1.844E+00	1.837E+00			
IY=21	1.849E+00	1.837E+00			
IY=20	1.858E+00	1.837E+00			
IY=19	1.871E+00	1.837E+00			
IY=18	1.891E+00	1.837E+00			

```
 IY=17    1.920E+00    1.837E+00
 IY=16    1.960E+00    1.837E+00
 IY=15    2.009E+00    1.837E+00
 IY=14    2.065E+00    1.837E+00
 IY=13    2.117E+00    1.837E+00
 IY=12    2.159E+00    1.837E+00
 IY=11    2.188E+00    1.837E+00
 IY=10    2.204E+00    1.837E+00
 IY= 9    2.210E+00    1.837E+00
 IY= 8    2.211E+00    1.837E+00
 IY= 7    2.210E+00    1.837E+00
 IY= 6    2.199E+00    1.837E+00
 IY= 5    2.114E+00    1.836E+00
 IY= 4    2.050E+00    1.836E+00
 IY= 3    1.968E+00    1.836E+00
 IY= 2    1.899E+00    1.832E+00
 IY= 1    1.885E+00    1.769E+00
 IZ=      21           22

**********************************************************************
USER:- NAME OF FILE CONTAINING FINAL FLOW FIELDS IS TM1
        LAST SWEEP =   100
        LAST STEP  =     1
```

APPENDIX I

PROGRAM CALCULATES THE DISTRIBUTION QUANTITIES FOR TURBULENT FLOW

```
C     THIS PROGRAM CF,ST,Q,H OVER THE VANE FOR
C     TURBULENT FLOW
      REAL*8 Y1(20),Y2(20),H(20),W(20),ST(20),Q(20),CF(20),RA(20)
      REAL*8 BZFRAC(20),EMU,GPGP,PR,HW,ZCOR(20),HCON(20),RO(20)
      REAL*8 RE2(20),CFT(20),Z(20),TAW(20),Y0(20),D1(20),D2(20)
      REAL*1 P(20),V(20),ARG(20),KE(20)
      INTEGER IZ
      GH=6.4E-03
      GD=10*GH
      GL=95.2E-03
      GTL=1.24*GL
      GBETA=4.
      GBETA=GBETA*3.1415927/180
      GTAB=TAN(GBETA)
      DELMAX=2.E-03
      GNBL=5.
      GPWR=2.
      EMU=1.E-05
      ROE=1.835
      PE=1.048E+05
      WE=888.5
      RUU=0.5*ROE*WE**2
      GAMA=1.35
      RW=287.
      CP=GAMA*RW/(GAMA-1.)
      HW=323.*CP
      HO=555.5*CP
      PR=0.9
      GPCP=EMU/PR
```

```
      DO 10 IZ=1,6
      Y1(IZ)=(1./5.)**GPWR*DELMAX
      Y2(IZ)=(2./5.)**GPWR*DELMAX
   10 CONTINUE
      BZFRAC(1)=42.373E-3
      DO 66 IZ=2,8
   66 BZFRAC(IZ)=42.373E-3+BZFRAC(IZ-1)
      DO 67 IZ=9,14
   67 BZFRAC(IZ)=84.75E-3+BZFRAC(IZ-1)
      DO 68 IZ=15,16
   68 BZFRAC(IZ)=42.73E-3+BZFRAC(IZ-1)
      DO 69 IZ=17,20
   69 BZFRAC(IZ)=11.295E-3+BZFRAC(IZ-1)
      DO 20 IZ=6,20
      Y1(IZ)=Y1(1)*(GD-(BZFRAC(IZ)-BZFRAC(5))*GTAB*GTL)/GD
      Y2(IZ)=Y2(1)*(GD-(BZFRAC(IZ)-BZFRAC(5))*GTAB*GTL)/GD
      Z(IZ)=(BZFRAC(IZ)-BZFRAC(5))*GTL
      READ(5,12) H(IZ),W(IZ),RO(IZ),KE(IZ)
      CF(IZ)=(2./(WE**2))*(RO(IZ)/ROE)*(KE(IZ)/3.33)
      REZ(IZ)=RO(IZ)*WE*Z(IZ)/EMU
      ARG(IZ)=0.06*REZ(IZ)
C     CFT(IZ)=(0.455/(DLOG(ARG(IZ)))**2)*0.4
      CFT(IZ)=(0.455/(DLOG(ARG(IZ)))**2)*0.77
      ST(IZ)=(CF(IZ)/2.)*(PR)**(-2./3.)
      HCON(IZ)=ST(IZ)*ROE*WE*CP
      Q(IZ)=(H(IZ)/CP)*(0.928*HO-HW)
C     WRITE(8,18) CF(IZ),ST(IZ),Q(IZ),H(IZ),Z(IZ)
C     WRITE(8,19) Z(IZ),CF(IZ)
C     WRITE(8,27) Z(IZ),ST(IZ)
C     WRITE(8,21) Z(IZ),Q(IZ)
C     WRITE(8,22) Z(IZ),H(IZ)
      WRITE(8,24) Z(IZ),CFT(IZ)
C     WRITE(8,28) REZ(IZ),CFT(IZ)
   20 CONTINUE
   12 FORMAT(3X,E10.3,3X,E10.3,3X,E10.3,3X,E10.3)
```

```
C 18  FORMAT(3X,E10.3,3X,E10.3,3X,E10.3,3X,E10.3,3X,E10.3)
C 19  FORMAT(3X,E10.3,3X,E10.3)
C 27  FORMAT(3X,E10.3,3X,E10.3)
C 21  FORMAT(3X,E10.3,3X,E10.3)
C 22  FORMAT(3X,E10.3,3X,E10.3)
  24  FORMAT(3X,E10.3,3X,E10.3)
C 28  FORMAT(3X,E12.5,3X,E12.5)
      STOP
      END
```

APPENDIX J

INPUT FILE FOR PRORAM CALCULATING TURBULENT FLOW QUANTITIES

H(IZ)	W(IZ)	RO(IZ)	KE(IZ)
5.690E+05	7.369E+02	2.309	5.230E+03
5.372E+05	6.452E+02	2.329	4.126E+03
5.194E+05	5.906E+02	2.325	3.531E+03
5.258E+05	6.019E+02	2.301	3.667E+03
5.262E+05	6.004E+02	2.300	3.661E+03
5.252E+05	5.964E+02	2.307	3.625E+03
5.233E+05	5.907E+02	2.310	3.572E+03
5.211E+05	5.842E+02	2.310	3.513E+03
5.190E+05	5.782E+02	2.307	3.459E+03
5.180E+05	5.756E+02	2.304	3.440E+03
5.170E+05	5.735E+02	2.299	3.424E+03
5.168E+05	5.737E+02	2.292	3.432E+03
5.165E+05	5.754E+02	2.281	3.455E+03
5.172E+05	5.976E+02	2.247	3.710E+03
5.163E+05	5.928E+02	1.876	3.812E+03

APPENDIX K

NOMENCLATURE

C_1, C_2, C_D	Constants used in turbulent model
C_f	Skin friction coefficient
H	Heat transfer coefficient
M	Mach number
P	Pressure
Pr	Prandtl number
Q	Heat flux
Re	Reynolds number
St	Stanton number
T	Temperature

GREEK LETTER SYMBOLS

δ	Boundary layer thickness
μ	Dynamic viscosity
ρ	Density
$\sigma_k, \sigma_\epsilon$	Constants used in turbulent model
ϕ	Any property at the grid node
ν	Kinematic viscosity

SUBSCRIPTS

comp	Compressible value
inc	Incompressible value
eff	Effective value
T	Turbulent quantity
lam	Laminar quantity
z	Local value in the flow direction
∞	Free stream value

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